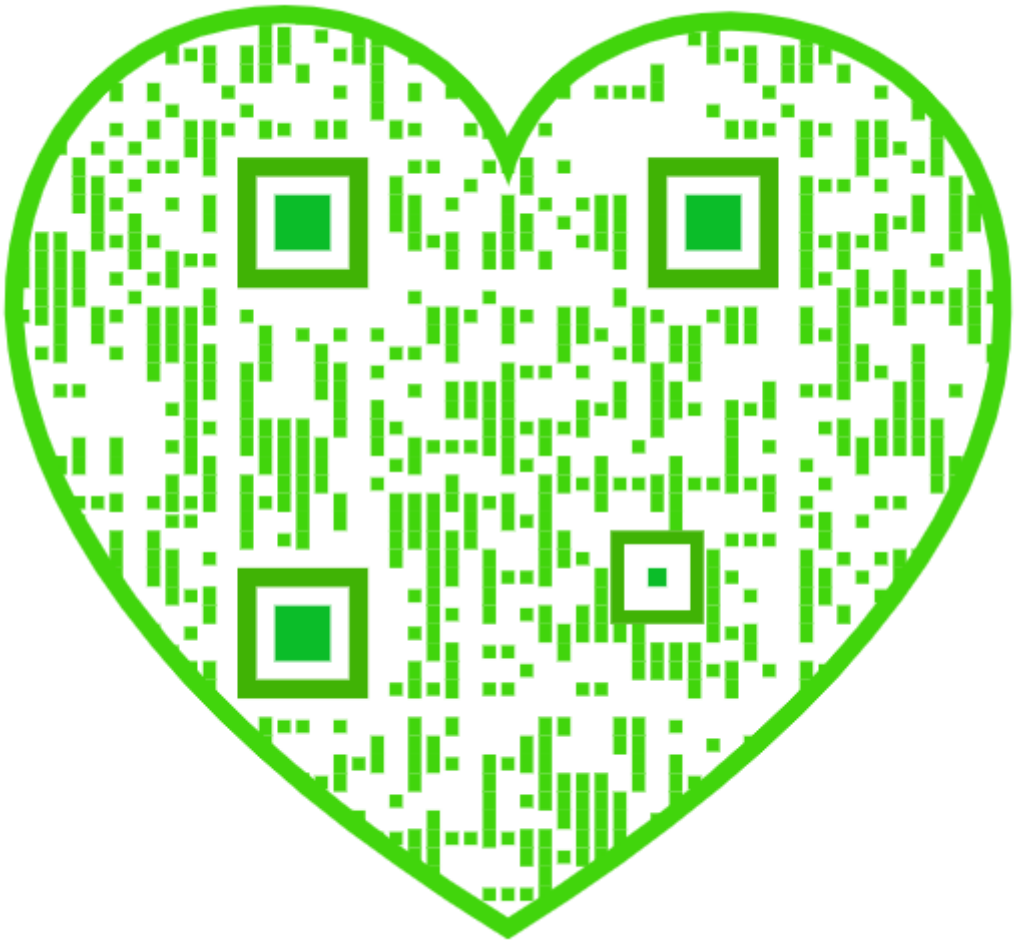

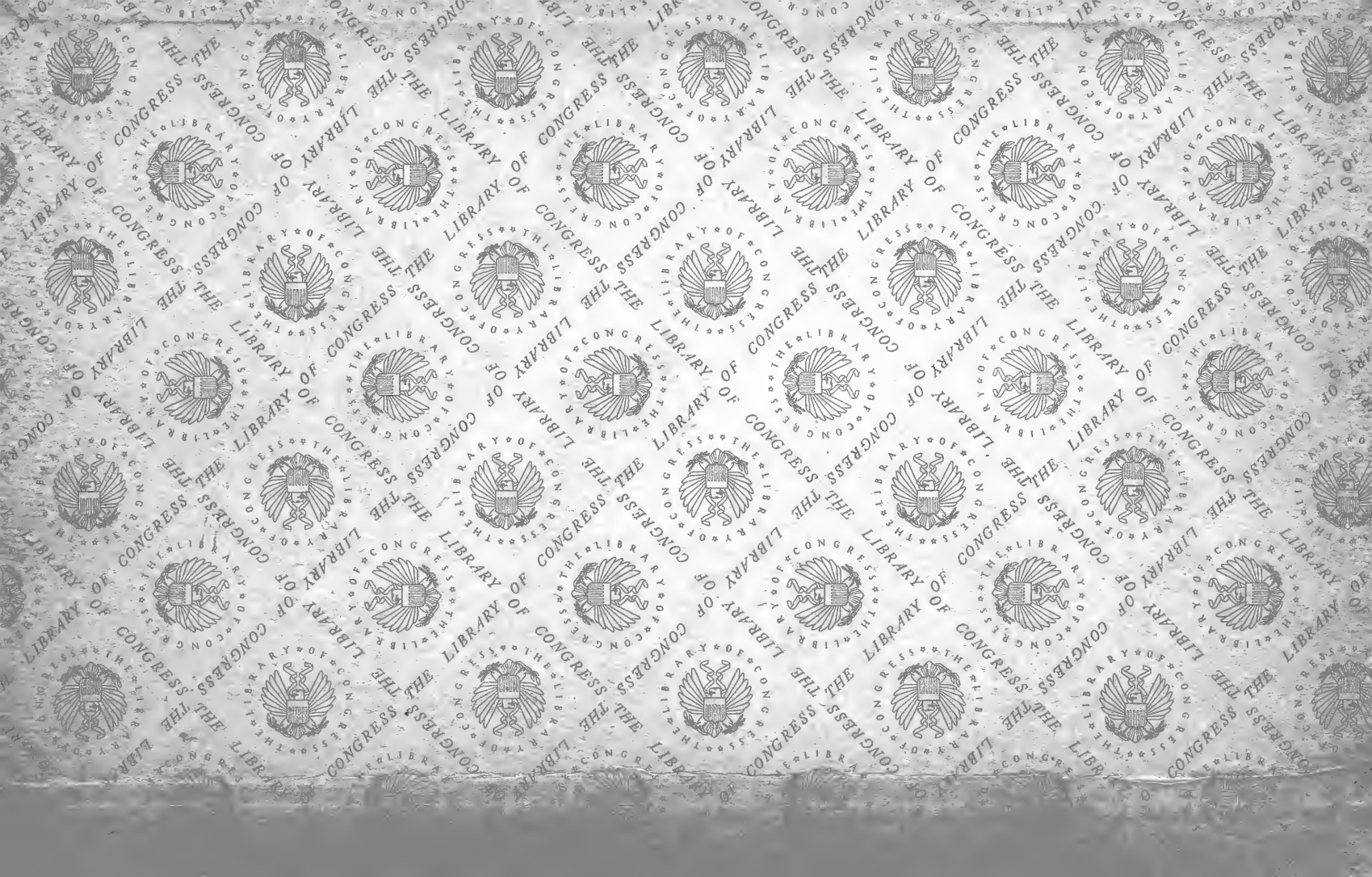
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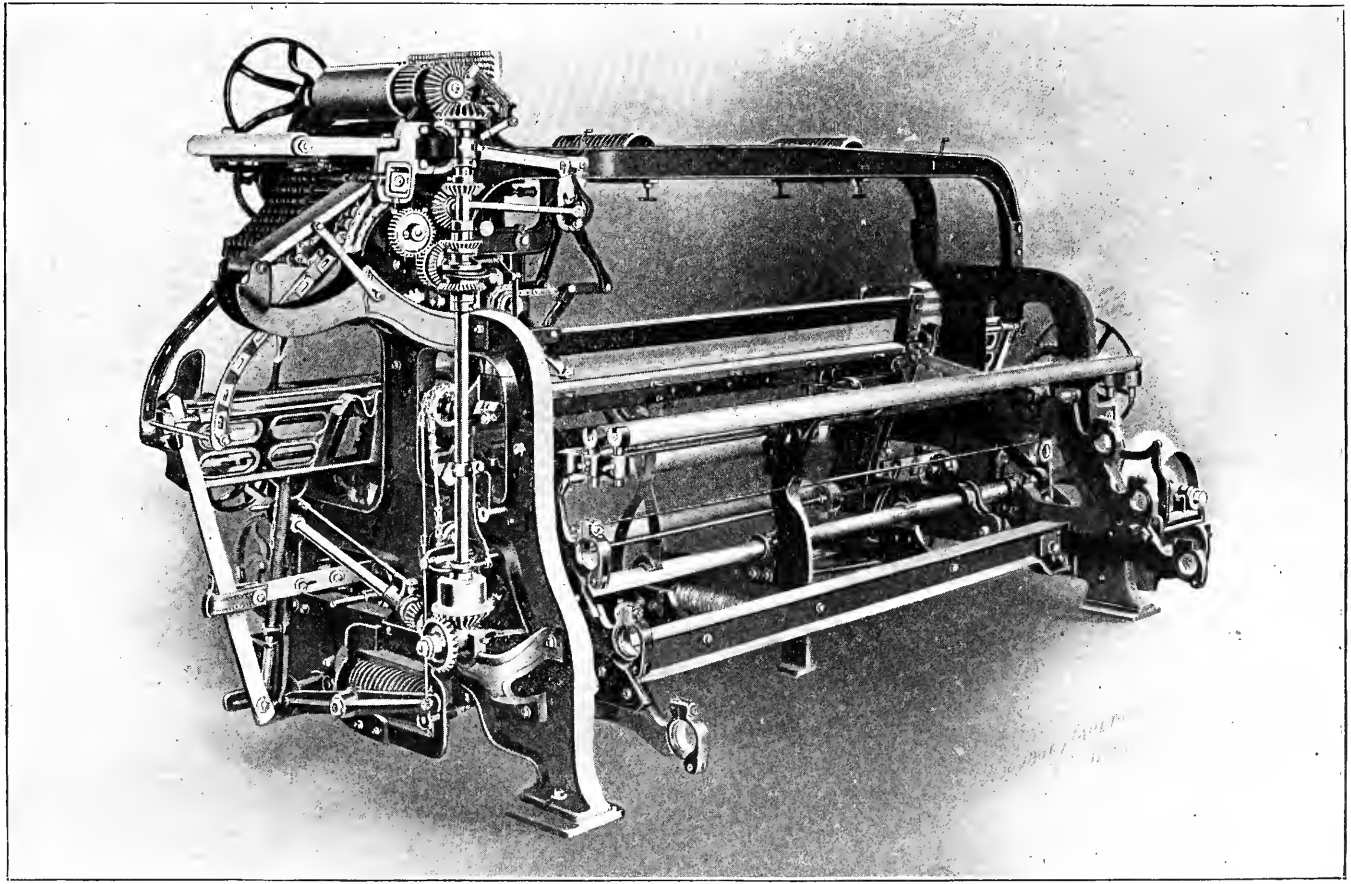

VIEW OF HEAVY WORSTED LOOM SHOWING HARNESS AND BOX MOTIONS

Crompton-Thayer Loom Co.

Weaving

A Practical Guide to the

MECHANICAL CONSTRUCTION, OPERATION, AND CARE OF WEAVING MACHINERY, AND ALL DETAILS OF THE MECHANICAL PROCESSES INVOLVED IN WEAVING

By H. WILLIAM NELSON
Head of Department of Weaving
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ILLUSTRATED

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Foreword

HE Textile Industry has shared to such an extent the modern tendency toward specialization, and has been marked by the development of such a multiplicity of types of machinery and special mechanical and chemical processes, that the various branches of this great industry to-day constitute distinct though closely related arts. The present volume is intended to furnish a comprehensive treatment of the fundamental branch of Weaving, serving the purposes of a practical guide to the mechanical construction, operation, and care of weaving machinery, and all details of the mechanical processes involved in weaving, from the preparation of the cotton, woolen, or worsted yarn, to the finishing of the complete woven fabric, and including helpful suggestions calculated to promote the efficiency of the textile worker and insure the highest standard of output.

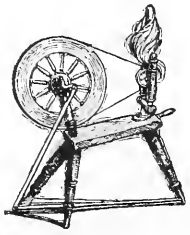
¶ Special stress is laid on the *practical* as distinguished from the merely theoretical or descriptive form of treatment of each topic, the work being based on a careful study of machinery, conditions, and needs as developed in the best American mills.

¶ This volume will be found especially adapted for purposes of self-instruction and home study, fitted not only to meet the requirements of an instruction manual for the beginner in the

art of Weaving, but also to serve as a reference work replete with useful information of the utmost practical value to the most advanced and experienced textile worker.

¶ The method adopted in the preparation of this volume is that which the American School of Correspondence has developed and employed so successfully for many years. It is not an experiment, but has stood the severest of all tests — that of practical use—which has demonstrated it to be the best method yet devised for the education of the busy workingman.

¶ For purposes of ready reference, and timely information when needed, it is believed that this volume will be found to meet every requirement.



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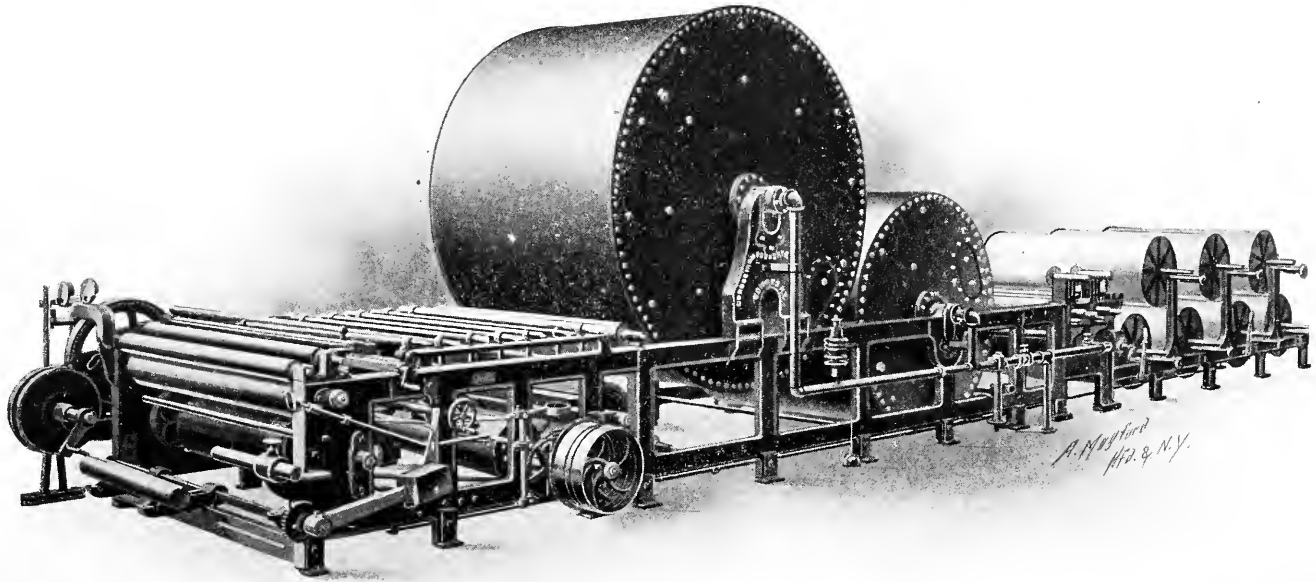


IMPROVED SLASHER FOR MAKING COTTON WARPS

Cohoes Iron Foundry & Machine Co.

WARP PREPARATION.

It should be the aim of every overseer to excel in his occupation; but success is dependent upon certain conditions which are often difficult to maintain. These conditions may be classified in a general way under the following heads:

1. Large Production.
2. Fine quality of Production.
3. Long life of the machinery in use.
4. Low cost of maintenance.

To lose sight of any one of these, or to sacrifice the last three for the first, indicates incompetence. Intelligent management takes into consideration all four conditions and holds them for an ideal.

COTTON WARP PREPARATION.

THE SPOOLER.

This machine, as its name implies, is for the purpose of spooling the yarn as it comes from the ring spinning frame. It is shown in Fig. 1. Apparently it is a very simple machine, but it is essential that it should be thoroughly understood. It is uneconomical to run it at a speed not suited to the quality and counts of yarn in preparation. In the first place, the spools run by gravity and merely rest on the base of the spindles; also, while the speed may be correct when the yarn is being run on an almost empty spool, the increase of circumference, as the yarn is added to the spool, increases the speed of the yarn and brings an added strain upon it. This is costly, because the extra strain causes the yarn to break frequently, and the spooler-tender is able to look after only about 50 instead of 75 spindles. In addition, the constant piecing means a larger percentage of knots in the yarn than is desirable for the best results. This should be thoroughly understood at the beginning. Poor spooling results in poor warps, and no later treatment can overcome this defect. Spooler-tenders should be trained to make as small and as good knots as possible; and if attention is

paid to the work at this stage there will be less trouble in the weave rooms.

Weak yarns can stand less speed than the stronger yarns; consequently the speed should be adjusted to the strength of the yarn. For example, a good 60's yarn would probably stand 800 revolutions per minute, but if the speed seemed too low when the spool was small and was increased to 850 or 900 revolutions,

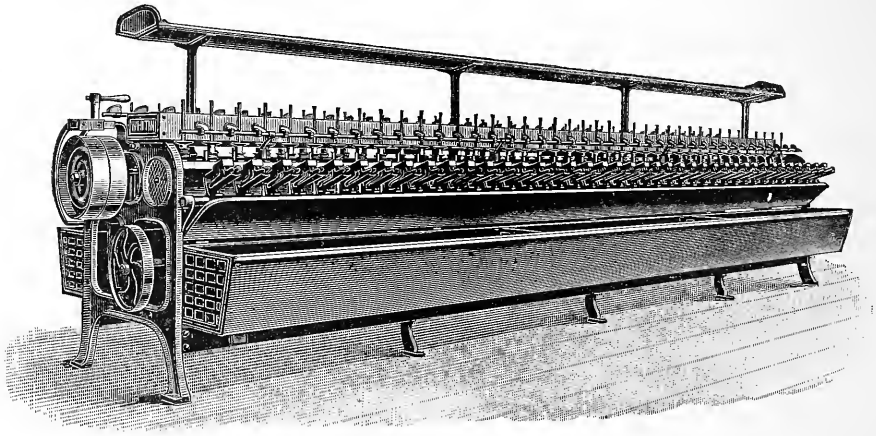


Fig. 1.

the loss would be greater than the gain because the yarn would break more frequently as the circumference of the yarn on the spool increased.

CALCULATIONS FOR SPEED.

It is customary to have the spindle run from 700 to 1,000 revolutions per minute, and the following is the method of calculation.

Multiply the revolutions of the main driving shaft by the diameter of the pulley on the same shaft, also by the diameter of the drum or tin cylinder, around which the driving bands pass: then multiply the driving pulley on the machine by the size of the whirl or whorl on the spindle, divide the first product by the second, and the result will be the speed of the spindle.

Suppose the main shaft is running at 300 revolutions per minute and the pulley on this shaft is $5\frac{1}{2}$ inches in diameter. If

the drum is 6 inches in diameter, the pulley on the machine 10 inches and the whirl $1\frac{5}{16}$ inches, what is the speed of the spindles?

$$\frac{\overset{\text{Rev. of Main Driving Shaft.}}{300} \times \overset{\text{Pulley on Main Shaft.}}{5\tfrac{1}{2}} \times \overset{\text{Diam. of Drum.}}{6}}{\underset{\text{Diam. of Machine Pulley.}}{10} \times \underset{\text{Diameter of Whirl.}}{1\tfrac{5}{16}}} = 754.28 \text{ revs. per min.}$$

About $755\frac{3}{4}$ revs. per min.

To find diameter of pulley for main driving shaft, speed of whirl given, multiply revolutions of whirl by diameter of whirl and by diameter of pulley on machine and divide the product by diameter of the drum multiplied by revolutions of main shaft.

$$\frac{\overset{\text{Rev. per minute of Whirl.}}{755.72} \times \overset{\text{Diameter of Whirl.}}{1\tfrac{5}{16}} \times \overset{\text{Diameter of Pulley on Machine.}}{10}}{\underset{\text{Rev. per minute of Shaft.}}{300} \times \underset{\text{Diam. of Drum.}}{6}} = 5\tfrac{1}{2} \text{ in. Diam. of Pulley.}$$

Banding. There are two systems by which motion is imparted to the spindle from the drum: by a single band for

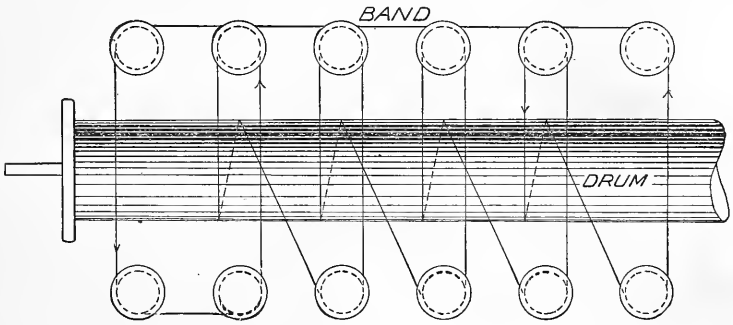


Fig. 2.

each spindle, or by connecting together four or more spindles on each side of the frame by one endless band, as shown in Fig. 2. Both systems have their advantages, but the latter is more common. One reason for this is that when a single band breaks that spindle alone is stopped, and is not readily seen. When the multiple band breaks, however, several are stopped, which attracts attention instantly. Again, the band which drives a number of spindles lasts much longer than the single band.

Building Motion. There are two distinct kinds of building motions. One builds a straight spool, the other builds a convex or rounded spool. The latter is by far the best, and is most commonly used. A convex wound spool holds more yarn than the straight wound spool, because it can be made larger in the middle without fear of the yarn being rubbed over the flanges. The

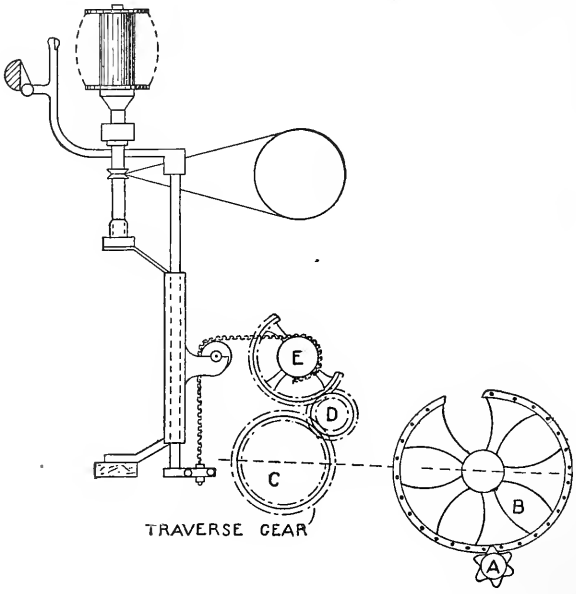
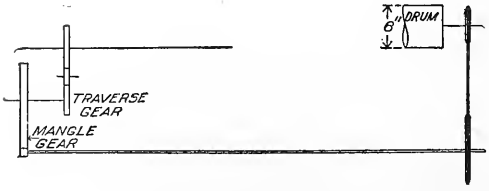


Fig. 3.

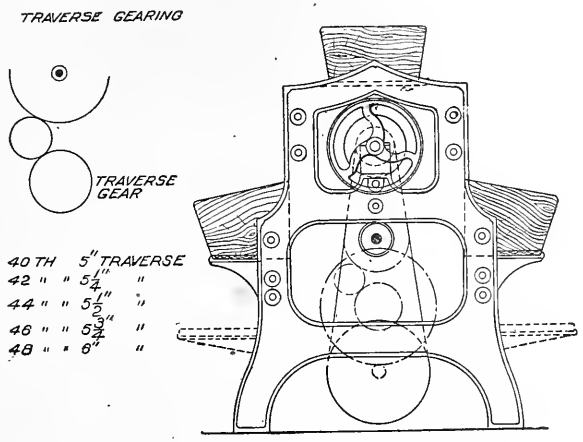


PLAN OF GEARS.

convex shape is caused by the builder rail traveling more slowly at the middle of the traverse, and in this way allowing more yarn to be placed on the spool at this point.

The building motion is as follows (see Figs. 3 and 4): A 6-tooth pinion, A, imparts motion to the mangle gear, B; on the

same shaft as the mangle gear is the traverse or change gear C. An intermediate gear D connects the traverse gear to the segment E, which is fixed on a shaft that extends from one end of the



END VIEW OF SPOOLER.

machine to the other. At different places on this shaft are small pulleys, to which are connected the chains that lift the builder rail. The mangle gear has a reciprocal motion, owing to the

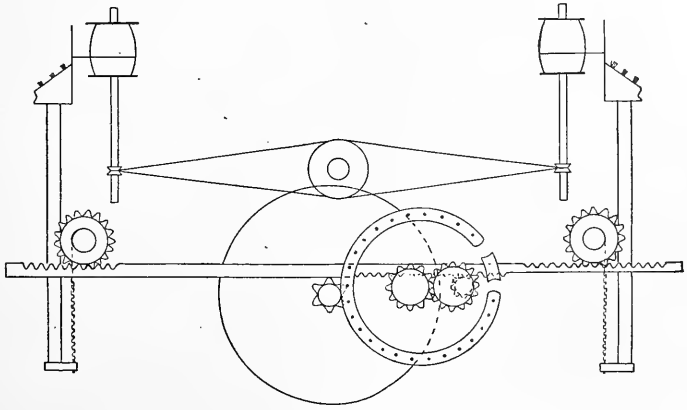


Fig. 4.

small pinion rotating on the inside as well as the outside of the gear. The mangle also has two different diameters, which cause a fast and slow motion to the builder rail, the largest diameter being at the center of the gear; this is the direct cause of the convex-shaped spool.

When calculating the speed of the traverse, two teeth must be added to the number of teeth or bars on the mangle gear, because there is a loss of one tooth as the small pinion passes round the end of the gear; and this occurs at both ends.

For example:

$$\frac{\text{Rev. of Main Driving Shaft.}}{\text{Pulley on Machine Shaft.}} \times \frac{\text{Pulley on Main Shaft.}}{\text{Pulley on Small Pinion Shaft.}} \times \frac{\text{Pulley on Small Machine Shaft.}}{\text{Teeth of Mangle Gear.}} \times \text{Small Pinion.}$$

$$\frac{300}{10} \times \frac{5\frac{1}{2}}{10\frac{1}{2}} \times \frac{2\frac{3}{4}}{62} \times 6 = 4.18 \text{ trav. per min.}$$

Some claim that the mangle ought to be calculated as an ordinary gear, but the foregoing is the result of careful measurements.

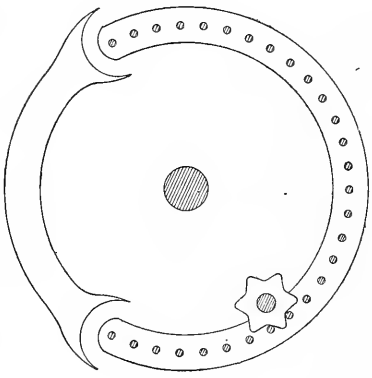


Fig. 5.

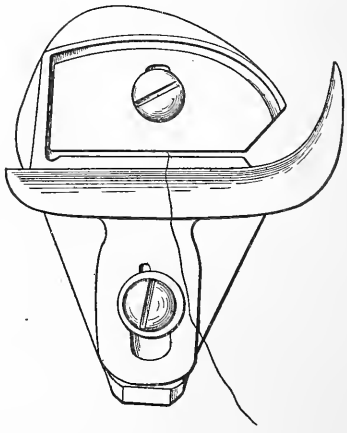


Fig. 7.

Fig. 5 shows the mangle of a straight-built bobbin, but as stated before, this motion is not of as great value as the elliptic mangle gear, on account of the greater production of the latter.

Bobbin Holder. The yarn is received from the spinning frame on a bobbin or pirn; it is then placed in the bobbin holder (shown in Fig. 6), which is in the form of a cradle or concave casting. Each cradle is supported on a rod which extends the entire length of the machine.

When setting the cradle, it should be tilted or inclined so that the yarn will have the least amount of friction; it can be readily seen that if the cradle has too steep an incline, there will be too much strain on the yarn when it is drawn from the lower end of

the bobbin; and of course the opposite is the case when the cradle is too flat. The cradles should be set so that they will cause as light and equal a tension as possible. Two swinging wires are attached to the upper portion of the holder, one at each side; these prevent the bobbin from being drawn out of the cradle while the yarn is being unwound; they also add a little friction to the yarn, and prevent it from rewinding around the bobbin if the spool should stop. If weak yarn is being spooled, it is best to have the end from the pirn pass between the swinging wires instead of under them. This will take off all the friction.

Thread Guide. There are two distinct kinds of thread guide; one is made from flat steel, about $\frac{5}{32}$ inch thick, with a slot cut in the plate through which the yarn passes on to the spool.

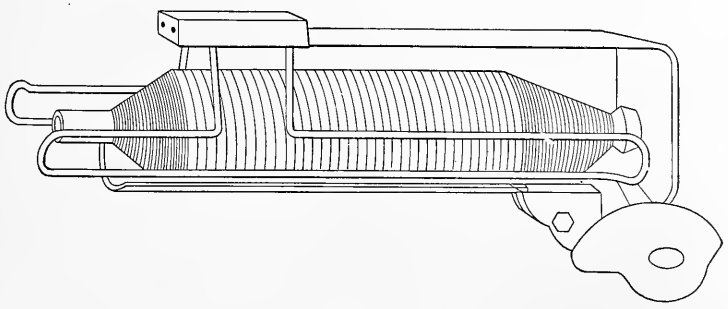


Fig. 6.

When the counts of yarn are changed, and there is a wide difference in the counts, it is necessary to change the guide, because if a fine yarn has been spooled, and a coarse yarn is desired, a guide with a larger slot is necessary; on the other hand, a smaller slot is required for finer counts. It is essential that the size of the slot conform to the size of the yarn, because the guide also performs the functions of a cleanser. If any foreign substance adheres to the yarn, or, as it sometimes happens, there are lumpy places in the yarn, it is best to have it cleansed at this point, otherwise it will remain in the warp, and cause poor cloth, or endless trouble to the weaver. So that if a coarse guide is used for fine yarns, the rough places pass through the guide and on to the spool.

The second kind of guide (shown in Fig. 7) is by far the best, and is most commonly used. There are different makes, but all

embody the same principles. These are made of adjustable parts, so that they can be used for different counts of yarn. The yarn passes over a rounded lip, and under the gage plate, which is adjustable. The rounded lip on this guide is very easy on the yarn. The guides are attached to the builder rail, and guide the yarn to the spool.

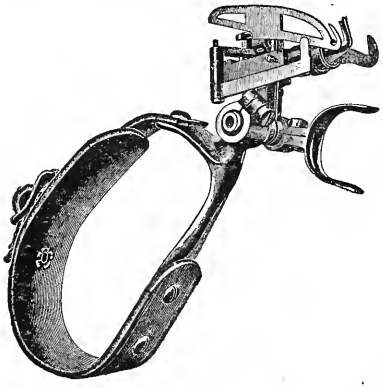


Fig. 8.

In some mills the warp yarn is spun on the mule, and the yarn is received at the spooler in cop form instead of on bobbins. Where this is the case, the cop is placed on an upright spindle instead of in a bobbin holder; the thread guide is also dispensed with, and in place of this is adjusted a wooden bar which has a piece of felt attached to it. The felt cleanses the yarn, and adds friction.

If the yarn is transferred from bobbins, it is customary to have an upright spindle near one end of the machine; this is for the purpose of running off soft spun or tangled bobbins.

Production. Mills differ in the amount of production of spoolers, but the following gives a general idea of what ought to be produced under ordinary circumstances:

18 to 10 counts, 3¼ pounds to 4½ pounds per day with the spindle running 750 revolutions.

50 to 28 counts, 1½ pounds to 3 pounds per day with the spindle running 750 revolutions.

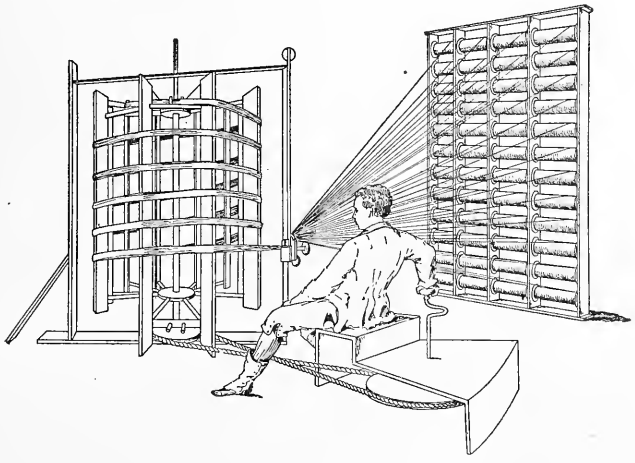
The above production would be enlarged about 1 pound for the coarser counts and about 4 ounces for the finer counts, with 825 revolutions of the spindle.

The finer the counts, the less will be the production. Not necessarily because of the more yards to the pound, but in some cases because of the added strain, and the necessary reduction in speed. It requires the production of 14 spindles on the ring spinning frame to supply one spindle on the spooler, for counts of yarn varying from 18's to 24's. 28's to 50's require from 15 to 20 spindles on the ring frame to supply one on the spooler.

One of the best inventions of recent date is the Barber and Colman knotter (see Fig. 8), by means of which more work can be accomplished than by hand; the knots are uniform, and as small as it is possible to make them.

BEAM WARPING.

The beam warper is for the purpose of making a warp for the back of the slasher; the ends of yarn, or threads from a number of spools that have been filled, are placed side by side on a beam, and when sufficient length has been run on the beam it is cut out and replaced by an empty beam, this order being followed until sufficient back warps or back beams have been made to fill up the creel at the back of the slasher.



OLD FORM OF COTTON WARPER.

Creel. The spools are placed in a creel, which may hold from 300 to 1,000. The creel is constructed in the form of a V, with the vertex nearest the machine. Down each leg of the V a number of upright bays or tiers are placed, according to the capacity of the creel; in the upright bay the spools are placed one above the other. The bays of the creel are fixed or changeable; this being determined by the amount of floor space available. If the floor space is small, changeable bays are used, and the angles of the

tiers, or rows of spools, can be changed to suit the altered bays. This is necessary when the angle of the bay is changed, because as the yarn is drawn off the spool, the added tension spoils the elasticity, if it does not break it.

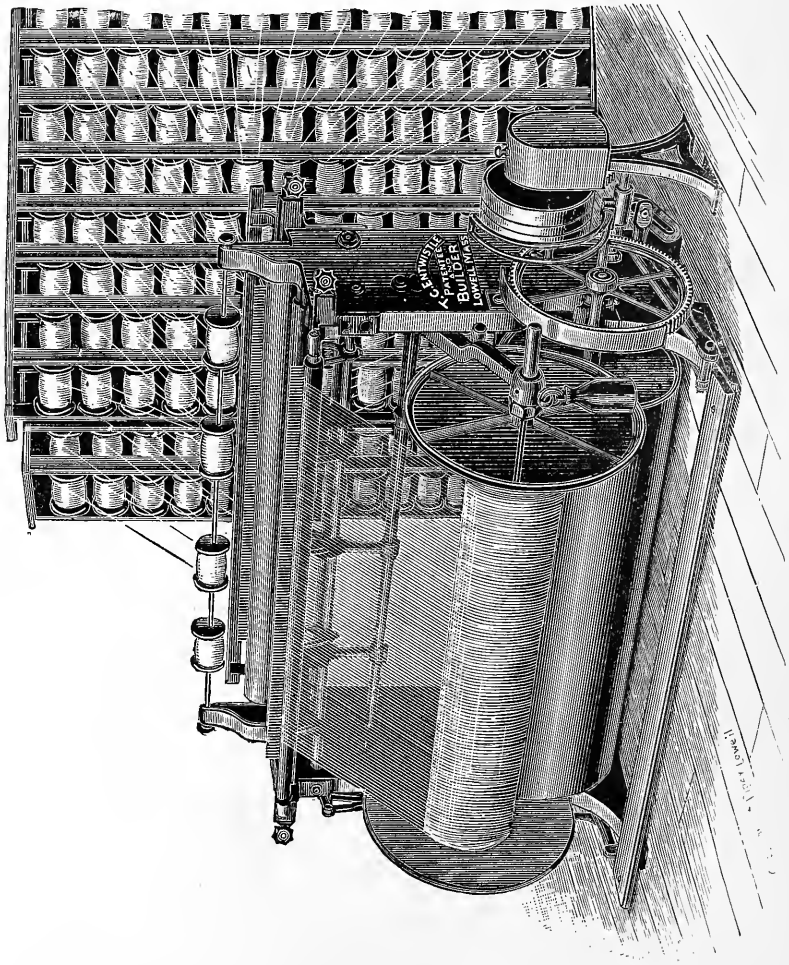


Fig. 9.

Expansion Reed. From the creel the yarn passes through an expansion reed. The purpose of this reed is to vary the width of the ends from the creel so that it will conform to the width of the beam on which it is to be placed.

Measuring Roll. From the reed the ends pass over the measuring roll and underneath the faller rod.

Faller Rod. This rod serves a twofold purpose. When the warper is stopped, the spools overrun a little, and instead of the yarn wrapping around the spool, and eventually being broken, the rod falls and keeps the yarn taut. Also, if an end breaks and the warp must be turned back, the faller rod takes up the slack yarn and prevents the ends from snarling. Some machines are constructed so that this rod is raised up instead of falling; it

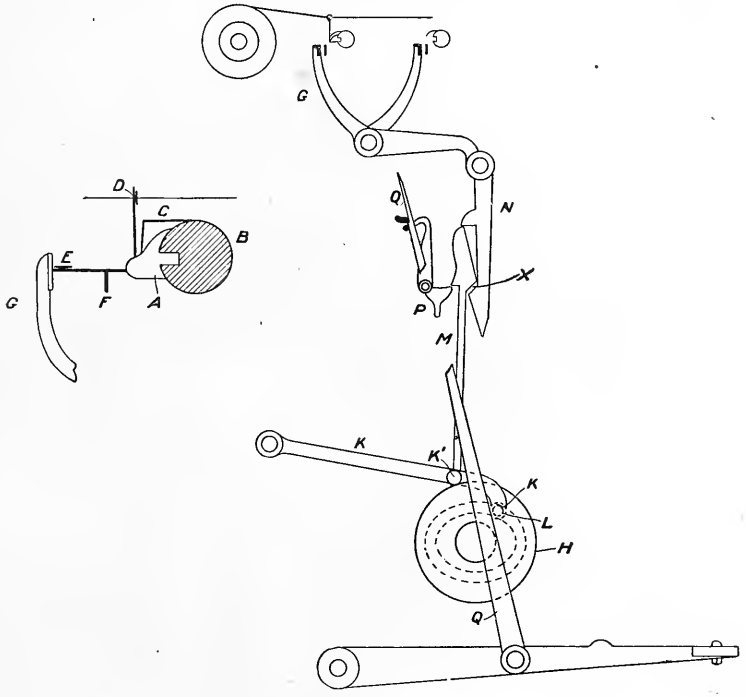


Fig. 10.

answers the same purpose. The yarn then passes over a standard rod and through the drop wires. The drop wires are actually the stop motion, and there are as many wires as there are ends in the warper; one wire for every end. Fig. 10 illustrates the entire stop motion. The detached sketch on the left shows the shape and construction of the drop-wire motion, but only one row; there being two rows in actual use, as shown in the large sketch.

A is a brass slide to which the drop wire is attached; this brass slide is placed in the slot in the tin holder. C is a strip of sheet iron attached to the tin holder, to prevent the brass slide from dropping out. When an end is passed through the loop of the drop wire and is held tight, the wire is upright, as shown in D. E shows the wire down, the end being broken. F is a flat bar which prevents the wire from dropping too low. G is a portion of an oscillating bar. There are two of these bars, one for each row of drop wires.

The motion that operates the oscillating bars is derived through a series of levers, from a shell cam, H, fixed on the outer end of the drum shaft. A small iron roller placed on the end of the lever K works in the groove of the cam at L. The upright catch rod M is connected by a stud to lever K at K′. A second upright lever, marked N, is connected to the arm of the oscillating bars; a projection on the latter rests on the top of lever M, and as M is raised by the action of the cam, it forces up N, thereby giving motion to the oscillating bars. The weight of lever N and its connecting bar keeps the projection in contact with M, when the latter is drawn down.

During the ordinary working of the machine the two beveled edges, X, are in close contact, but when a wire drops down, the end of yarn being broken, the oscillating bars are prevented from passing the usual distance, and as the cam draws down lever M the catch point on M is forced over on the catch of the shipper lever, P; this in turn will force off the shipper rod and stop the machine. When the end is tied up and the machine started, the beveled edges return to place. Q is the shipper rod, attached to a footboard, by means of which the operative starts up the machine. From the drop wires the ends pass through a second expansion comb over a rod to the beam.

Expansion Comb. The purpose of this comb is the same as the reed at the back of the machine; that is, to contract or expand the width that the ends occupy, to conform to the width of the beam on which they are placed. If the space is too wide, the ends crowd up on the sides, and when they are drawn off in the slasher the side ends become loose while the rest are tight. If the space is not wide enough, the beam is not filled up equally and

the results are as poor as in the former case. Thus we see that care should be taken to have the ends pass onto the beam as evenly as possible. This difference between the reed and the comb is as follows: the reed has a cap on it to prevent the ends from coming

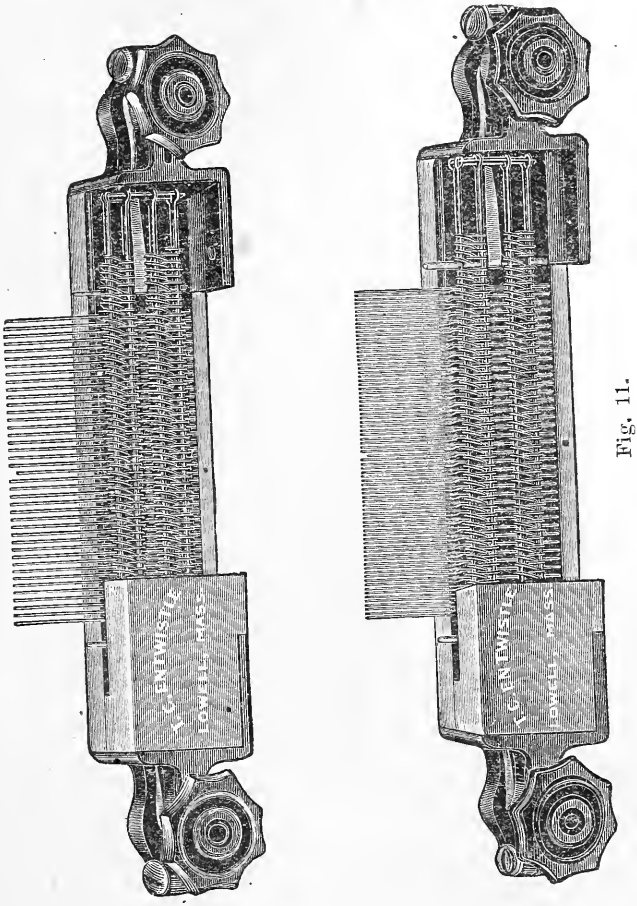


Fig. 11.

out at the top, while the comb is open, so that the end can be passed over from one dent to another. Fig. 11 shows two forms of expansion combs with varying numbers of dents to the inch.

Beam Drive. The beam is driven by friction, that is, it rests on a driving drum, which is generally twelve or eighteen inches in diameter. Owing to the beam being thus driven, the yarn is placed on it at a constant speed, no matter whether it is a large

or small beam. If the drum is 36 inches in circumference, for instance, and is driven at a constant speed, it will take just as long for the drum to turn an empty beam the distance of 36 inches as it would to turn the distance of 36 inches on a full beam. So that if the beam when it is full of yarn measures 3 yards in circumference, it will take three times as long to turn the full beam as it did to turn the empty beam, when it was 36 inches in circumference. While the yarn does not travel faster as the beam increases in size, the spools on the creel travel faster as the yarn is taken off the spool; consequently there is a greater strain on

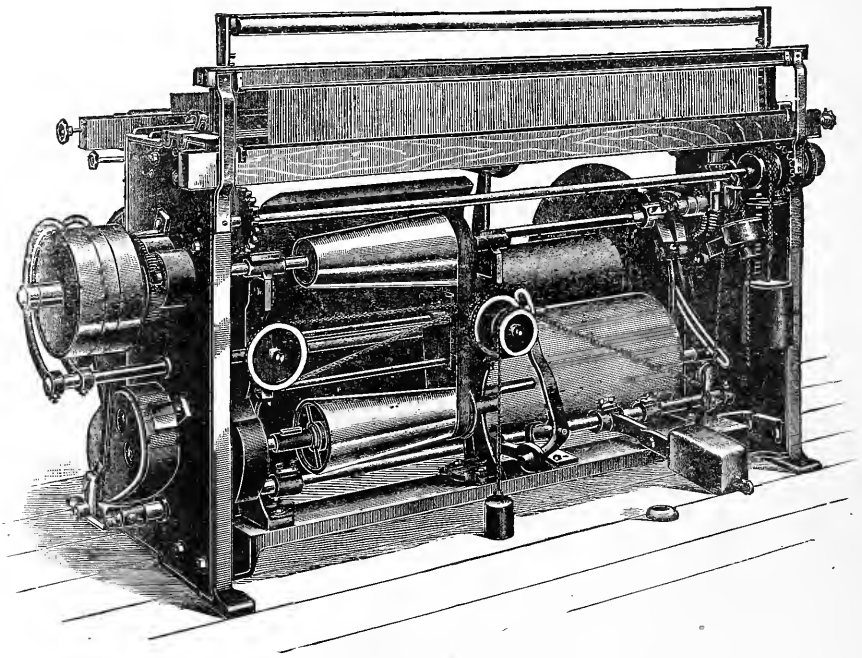


Fig. 12.

the yarn when there is less quantity on the spool. This often causes the yarn to break, which is detrimental to good weaving, inasmuch as knots in the warp yarn increase the amount of defective cloth.

Cone Drive. To overcome the difficulty of increased strain, the cone drive (shown in Fig. 12) has been added to the warper; this regulates the speed of the drum, so that as the warp increases in size and the spools decrease in size, the speed of the drum can

be reduced. Though the drum travels slower at this time, the machine can travel faster when the spools are full.

It is claimed that by the use of the cone drive there is added production and better quality of warp yarn, because added tension not only breaks the yarn, but takes the elasticity from it. The loss of elasticity is a great defect.

Variable Motion. There are two distinct speeds to a warper: first, the ordinary speed at which a warper is run when all is straight and the yarn good; second, the slow speed. This change of speed is advantageous in starting up the machine; if the machine is started up at full speed, the ends are likely to break

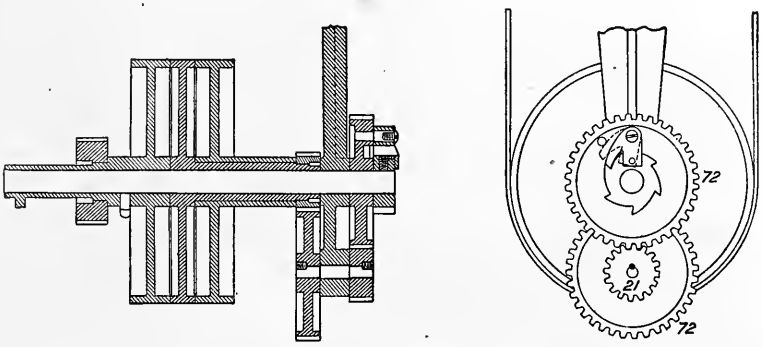


Fig. 13.

out. Also, when the faller rod is down and there is some slack yarn to be taken up, the machine should be run slowly until the yarn is tightened and the ends are traveling straight from the spool. The slow motion is obtained as follows: an additional pulley (see Fig. 13) is placed on the driving shaft, between the ordinary fast and loose pulley. This intermediate pulley has an extended sleeve attached to it. A 21-tooth gear is fixed on the sleeve, and meshes with a 72-tooth gear; on the same stud with the 72 is another 21, but attached to the 72. The second 21 imparts motion to another 72-tooth gear, which is loose on the sleeve of the slow pulley. A ratchet is fixed on the end of the driving shaft; there is also a pawl attached to the face of the last 72-tooth gear. When the belt is on the slow-motion pulley, motion is imparted to the 21 gear, which is fixed on the sleeve of the pulley,

from this 21 into the 72, from this 72, through the 21 connected to it, into the second 72, and as that is turned, the pawl engages in the teeth of the ratchet, and in this way turns the driving shaft.

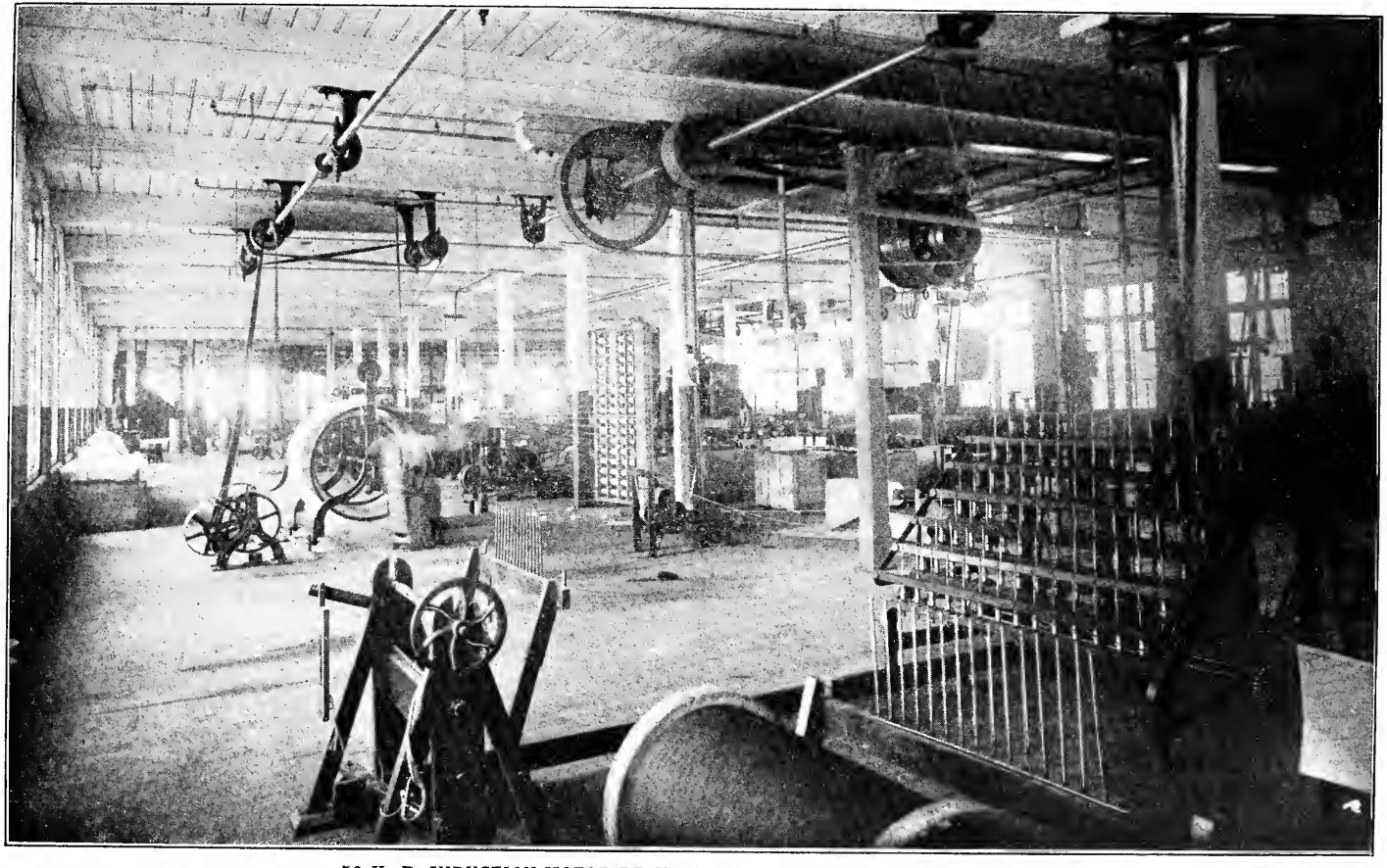
Measuring Motion. This is a combination motion for Beam and Ball warper, and the calculation for one will apply to both.

The simplest method of calculating the velocity ratio of a train of gears is to multiply the drivers together, the drivens together, divide the one in the other, and the quotient will be the answer required.

The motion is as follows: the measuring roll is 12 inches in circumference; on the end of this roll is a single worm, driving a 48 gear. Attached to this is a 16 gear, imparting motion to a carrier gear of 47 teeth; this drives a 50-tooth gear, which is the cut gear. Attached to the cut gear is a 16-tooth gear driving a 64 gear, which also has a 16 gear attached to it; this imparts motion to the leese gear, which has 80 teeth. The carrier gear is left out of the calculation.

$$\frac{\overset{\text{Cut Gear.}}{48 \times 50} \times \overset{\text{Leese Gear.}}{64 \times 80}}{\underset{\text{Worm.}}{1} \times 16 \times 16 \times 16} = 3{,}000 \text{ feet} = 1{,}000 \text{ yards.}$$

The above train of gears will give 1,000 yards. The 1 represents 1 revolution of the worm, which is also 1 revolution of the measuring roll, and that being 12 inches in circumference will mean that 12 inches of yarn has been placed on the beam during 1 revolution of the worm, or 1 tooth of the first 48 gear. This train of gears will measure 3,000 feet of yarn or 1,000 yards. When the leese gear has made 1 revolution, the measuring roll has made 3,000 revolutions, and being 12 inches in circumference, 3,000 revolutions will equal 1,000 yards. The number of teeth in the cut gear A corresponds to the number of yards in a cut; therefore, if this gear contains 50 teeth, the number of yards in each cut will be 50. Three teeth on the 48 gear equal one yard: $48 \div 16 = 3$, the motion having been reduced three times before it is imparted to the cut gear; thus it is that 1 tooth on this gear means that 1 yard of yarn has passed on to the beam. B is the leese gear which determines the number of yards in a leese,



50 H. P. INDUCTION MOTOR DRIVING WINDING AND REELING MACHINERY
J. R. Montgomery Co.

or the number of yards in the whole wrap. By the substituting of the 64 gear below the cut gear the ratio will be equal to 4 to 1. Thus the number of teeth in the gear B will be 4 times greater than the number of cuts in the leese.

Example. We require 1,000 yards of yarn on the beam, and there are 50 yards in a cut, so that we shall have 20 cuts in the warp. Four times the number of cuts in the warp will be the gear; $20 \times 4 = 80$ gear.

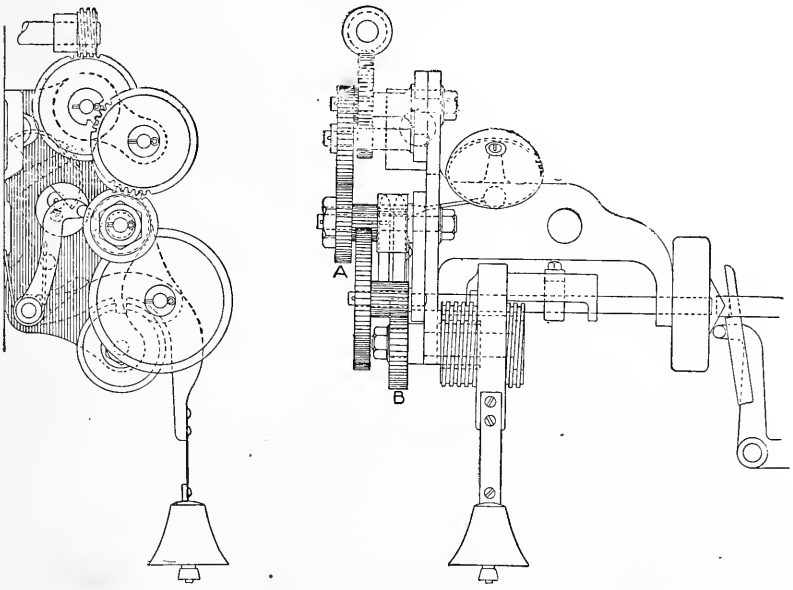


Fig. 14.

The hub of the leese gear is cut in the form of a worm, with a slot in it, and at every turn of the hub a catch point on a small lever drops in the slot. This lever is connected with the shipper rod, so that when the machine is stopped a bell is rung. If more than 1,000 yards are required, say 3,000 or 4,000, then 3 or 4 turns of the hub will give the required number of yards. The gears can be changed to give a longer length of yarn before the machine stops, and any number of yards can be placed on the beam.

It is often necessary to change both cut and leese gear when

an odd number of yards are required, and the following rule will give the gears necessary for the required length:

First divide the total number of yards into wraps or leeses, that is, several turns of the hub of the leese gear, thus bringing the number of yards within the range of the motion. Having obtained the number of yards in one wrap or leese, the gears must be chosen to produce this number of yards. First find the cut gear, which must be between 20 and 80, as this is the range of gears that can be placed on the stud. Divide the number of yards in the leese by any number between 5 and 20 that will give as a result a gear between 20 and 80; the number divided by will be the number of cuts in a leese; multiply this by 4, and the result will be the number of teeth in the leese gear.

Example. Give the necessary gears for a warp of 5,760 yards.

$$\frac{5{,}760}{6 \times 16} = 60 = \text{Cut Gear.} \qquad 16 \times 4 = 64 = \text{Leese Gear.}$$

We divided the total by 6, thus giving us 6 turns of the hub and 960 yards in each wrap. We further divided the 960 by 16, which gave us a 60-cut gear, meaning 16 cuts with 60 yards in each cut; we then multiplied the number of cuts by 4, and obtained a 64-leese gear.

In the train of gears first take out the cut and the leese gears and insert the ones obtained above.

$$\frac{48 \times 60 \times 64 \times 64}{1 \times 16 \times 16 \times 16} = 2{,}880 \text{ feet} = 960 \text{ yards}$$

$$960 \times 6 = 5{,}760 \text{ yards.}$$

Example. What gears are required for a small warp of 900 yards? One wrap or leese will be sufficient.

$$\frac{48 \times 75 \times 64 \times 48}{1 \times 16 \times 16 \times 16} = 2{,}700 \text{ feet} = 900 \text{ yards.}$$

The beams that are used on the warper are back beams for the slasher, and the number of spools that are placed in the warper creel determines the number of back beams required for the slasher, and from which the warp for the loom is made. The number of ends required for the warp when ready for the loom is several times more than the number of ends that the warper creel will hold.

Example. If a warp of 2,500 ends is required, how many spools must be placed in the creel and how many back beams made for the slasher? The capacity of the creel is 530 ends. We leave out the 30 ends and run 5 back beams of 500 ends each. This is a better division than 4 beams of 530 ends each, making a total of 2,120 ends; for in order to place on a beam the remaining 380 ends, the expansion combs must be altered, the drop wires taken out, or tied up, and several other changes made. In addition, the warp in passing through the slasher would not be as even as when all the back beams were equal, for then there is one equal layer upon another. Before discussing the slasher we will explain the Long and Short Chain systems of dressing.

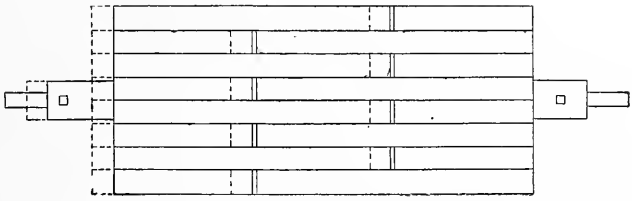


Fig. 15.

Expansion Drum. In mills where a great variety of goods is made, both as regards quality and widths, it is desirable to have a changeable drum on the warper. It saves cost in the number of warpers, and also overcomes the difficulty that often results from having the back beams too wide. We know that some do not concede this point, but in well-equipped fine mills it is not uncommon to have several widths of warpers, so that when making a warp that is narrower than usual, it is run on the narrow warper. This is a great advantage, because the straighter the yarn runs through the slasher, from creel to loom beam, the better are the side ends run on the loom beam. A little extra width should be allowed at the creel for the size to penetrate into the yarn when passing through the size box. The drum can also be used very profitably in the warping of cord warps; that is, warps used for adding a cord stripe to the cloth and also for leno cord warps.

The drum can be made of strips of wood of about 3 inches in width, 1 inch in thickness, allowing the alternate strips of each

half to be a little longer than the others, so that the extended strip from one side will fit into the shorter one on the other side. (See Fig. 15.) By this arrangement these strips can be extended or narrowed to suit the width of the beam, and each half screwed on the driving shaft.

EXAMPLES FOR PRACTICE.

1. A main shaft runs 250 revolutions per minute; there is a 7-inch pulley on this shaft, and a 10-inch pulley on the machine; the drum is 6 inches in diameter, and the whirl on the spindle is $1\frac{3}{8}$ inch. What is the speed of spindle?

Ans. 763.63 revolutions.

2. A main shaft runs 270 revolutions per minute. Diameter of the drum on spooler is 6 inches, pulley on spooler 8 inches, diameter of whirl $1\frac{1}{4}$ inches. In order that the spindle shall run 972 revolutions per minute, what size pulley would be required on the main shaft? Ans. 6-inch pulley.

3. A warp of 4,500 yards is required. The cuts are to be 50 yards in length; what gears are required to give the requisite number of yards?

Ans. { 50 cut gear.
72 leese gear.

4. What are the gears required to produce a warp of 8,400 yards in length?

Ans. { 60 cut gear.
80 leese gear.

COLORED WARPS.

Long Chain. Colored yarns, apart from the dye vat, must pass through an extra beaming process before they reach the slasher. In the long-chain system, instead of placing the ends on a back beam for the slasher, as described in the last process, they are drawn from the warper in the form of a ball or chain, and are then conveyed to the dye vat. After this process the chain is beamed on a long-chain beamer, the beam being carried to the slasher, where the yarn is sized and placed on the loom beam. These chains are from eight hundred to several thousand yards in length, more often the latter.

Balling Machine. This machine (Fig. 16) is similar to the beam warper up to the front expansion comb. At this point a leese reed takes the place of the comb.

Leese Reed. The leese reed wires have a hole cut in them; a thread passes through the hole and one between the wires. Thus while each alternate thread is through a hole in the wire, the rest

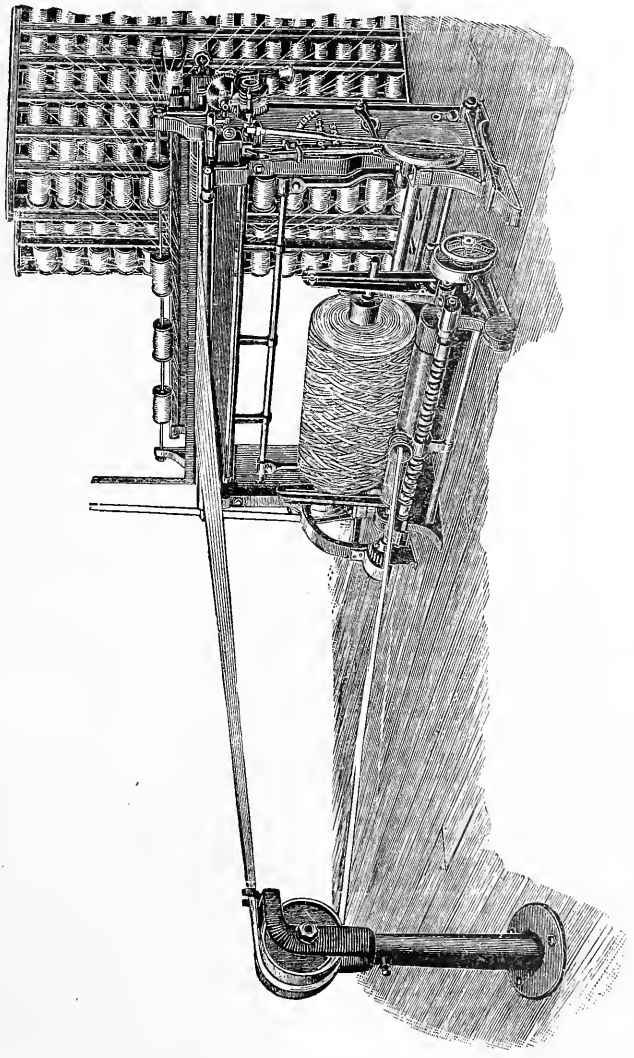


Fig. 16.

are between the wires. This reed (Fig. 17) is for the purpose of placing a leese in the threads, which keeps each thread separate and prevents tangled warps. The leeses are placed in the yarn at various

distances, according to the number of yards required, generally from 500 to 1,000 yards each. It is absolutely necessary that the leeses be placed in the yarn at the required distances. However, tangled warps are sometimes caused by carelessness on the part of the dyer, even if the leeses are carefully placed.

Another advantage in having the leeses in the yarn is that if a number of ends are broken during the beaming process, the threads can be pieced up in the best possible manner; when the next leese comes along, every thread can be straightened and the warp made as good and straight as when first beamed.

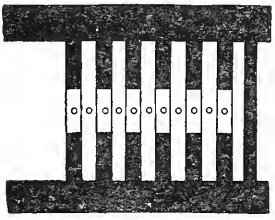


Fig. 17.

From the leese comb the yarn passes through a trumpet which acts as a condenser. This trumpet is placed on a stand that supports a pulley, around which the yarn passes. The pulley is about 10 or 12 feet from the warper, to allow the gradual condensing of the yarn into a small space before it winds around the ball. From the pulley the yarn passes back to the warper. The balling mechanism is placed where the driving drum is usually found on the beam warper. The balling mechanism is driven from the same source as the drum; the ball roller resting between the driving drums and receiving motion from them.

Traverse Guide. The yarn is guided on to the ball roller by means of a trumpet slide, whose base runs in the slot of an endless worm, with right and left thread, which guides the trumpet right to left, then left to right. Fig. 18 shows clearly the construction of the machine.

Overhead Baller. There is also the overhead baller (Fig. 19), which is considered a good machine. Less space is required for this machine than for the first one. Instead of passing straight from the machine to the condenser trumpet, the yarn passes down and under a platform, around a roller and up over the condenser pulley, then down to the beamer. This method allows the operative to stand close to the work and more easily attend to the broken ends. When the ball has attained the required length, it is taken to the dye vat. The yarn passes through the vat in

chain form and is then put through the drying process. It is then ready for the beamer.

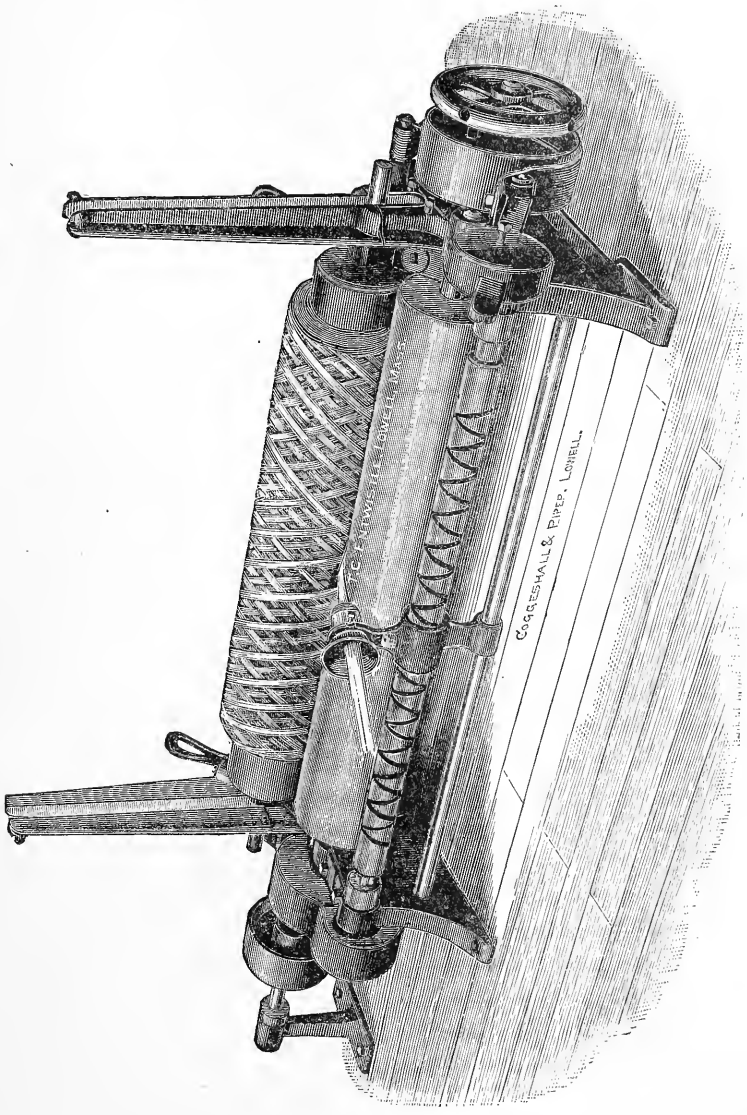


Fig. 18.

Winding Machine. In spite of all the care that a dyer can take while the chain is passing through the vat, an occasional tangled warp can scarcely be prevented. To overcome this defect

the winding machine (see Fig. 20) has been invented. This wraps a cord of sufficient strength around the chain, and after the yarn has been dyed the cord is taken off. This machine has been the means of reducing tangled warps at least 50 per cent, which, in consequence, greatly improves the quality of the warp.

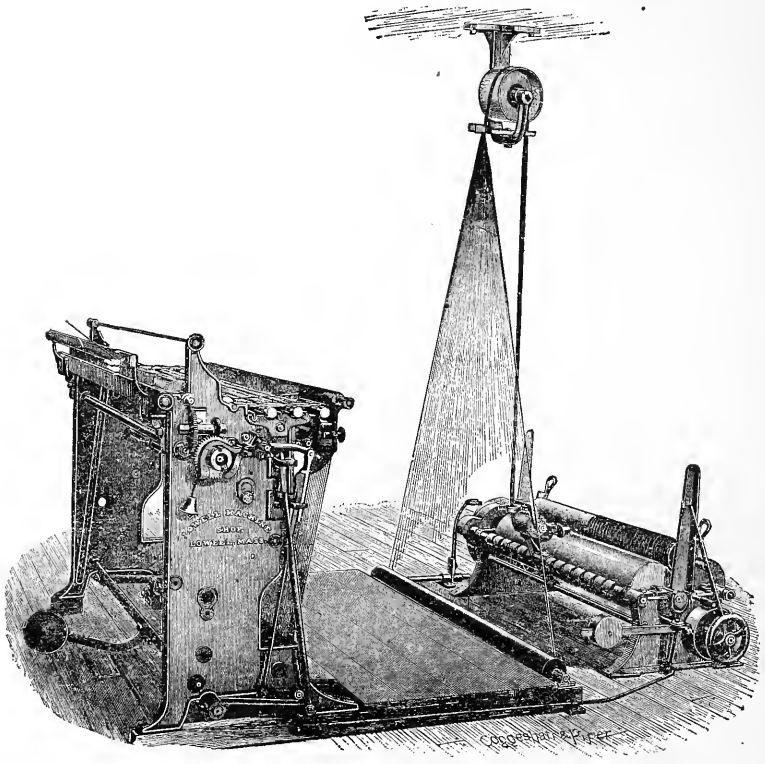


Fig. 19.

The creel of the ball warper is generally made to hold from 500 to 1,400 spools. If desired, the makers construct larger machines, but the best results are obtained by using a machine holding a medium number. These can be more readily handled in the several processes through which the chain passes, and are also more economical from the warper standpoint.

Double Screw. Chain warpers are also built with a double screw, so that two balls of a small number of ends can be made

at the same time. This is shown in Fig. 21. It is especially valuable when a small number of ends of different colors are required.

The ordinary beam warper can be changed into a ball warper; the appliances necessary for constructing the ball being additional parts.

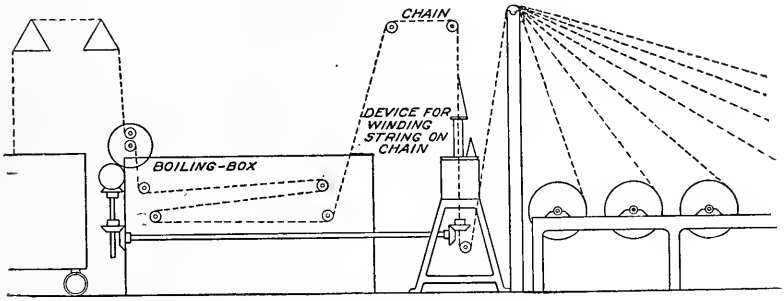


Fig. 20.

Chain Separator. This is a necessity in the colored mills, and is for the purpose of dividing a chain into several parts. For example, 100 ends are required, and there are 500 ends in the chain; the whole chain is passed through the separator, the ends required being counted off (the leese being retained in both sec-

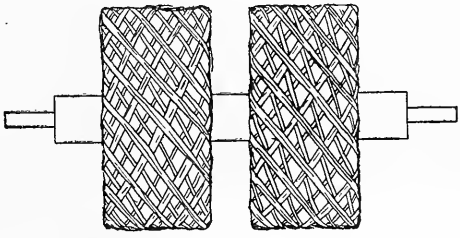


Fig. 21.

tions), after which the yarn is allowed to fall into a box provided for the purpose. It is then carried to the back of the long-chain beamer. When a mill is equipped with a chain separator, several chains having a small number of ends can be run together through the dye vats. This is desirable when the warper creels are small and the standard patterns are narrow.

Linker. For the purpose of shortening the length of a chain

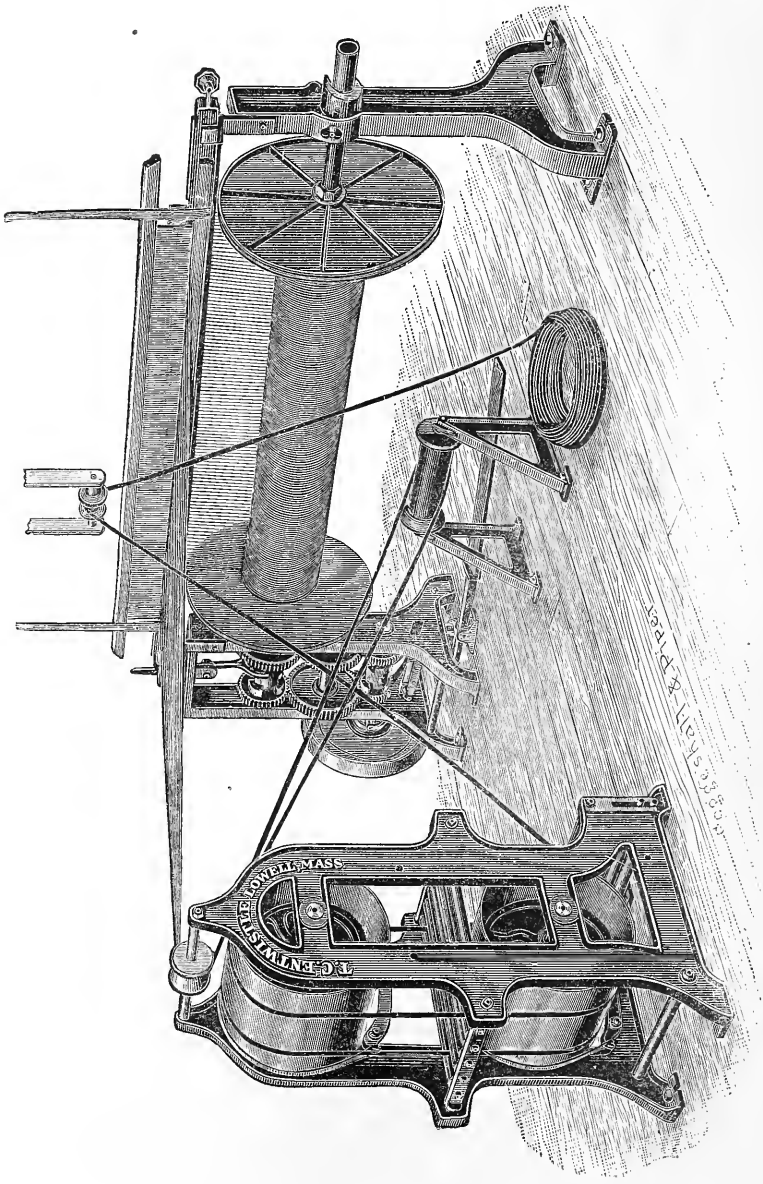


Fig. 22.

that is to be bleached, this very ingenious machine has been made. It effects a great saving, not only by preventing tangles, but by increasing the amount of yarn that can be handled in a given time.

Long-Chain Beamer. After the yarn is dyed it must be beamed on the back beams for the slasher, so that the sizing compound can be added. The ball of colored yarn is placed under a wood eyelet suspended from the ceiling. Through this eyelet the yarn passes to the bottom of the friction drums, and these, as the name implies, add friction or tension to the yarn while it is being placed on the beam. The friction on the yarn is increased by wrapping it a greater number of times around the drums. From the drums the yarn passes around a wooden roller at the foot of the beamer, then back to an iron pulley on the top of the drums and through the swinging comb, then through the expansion comb, and finally to the beam. The drums should be at least 20 feet from the beamer; the longer the space up to a certain point the better the results. By having the drums this distance from the beamer the yarn is well opened out before it reaches the swinging comb. A long-chain beamer is shown in Fig. 22.

Expansion Comb. The purpose of the leese is now shown; the beamer tender is enabled to lay the threads side by side in the expansion comb. They must be distributed as equally as possible, for two or three extra ends in one dent make a ridge on the beam. This means added circumference to the yarn, and causes those threads to be broken or unduly strained.

Swinging Comb. After the yarn is placed in the expansion comb and widened out to fill the space equally between the beam heads, the operative applies the power to the beamer by means of a foot-board, which is connected to the friction pulley. The speed of the beamer can be varied by the changing of a clutch gear. In operating, the tender has one foot on the shipper-board, in order to apply or disconnect the power, and one hand on the swinging comb, moving the comb backward and forward. If a snarl appears in the yarn it is readily detected, for it will pull on the comb. The operative immediately stops the machine. The colored yarn beams are taken to the slasher from this machine.

The Quiller. The purpose of this machine is to transfer colored yarns from the chain to the bobbin or quill, either for the

shuttle or for export. The quiller has friction drums placed about the same distance off as are those of the beamer; there is also a swinging comb. The yarn passes from the comb over guide rods to some 9 or 10 rows of bobbins, placed on upright spindles. There is also a guide or builder rail for each row of bobbins. The spindles are driven in a similar manner as are the spooler spindles, and the builder rail is controlled by a heart-shaped cam. This is a valuable machine, more especially for the heavier counts of yarn, as it builds a very perfect bobbin. (See Fig. 23.)

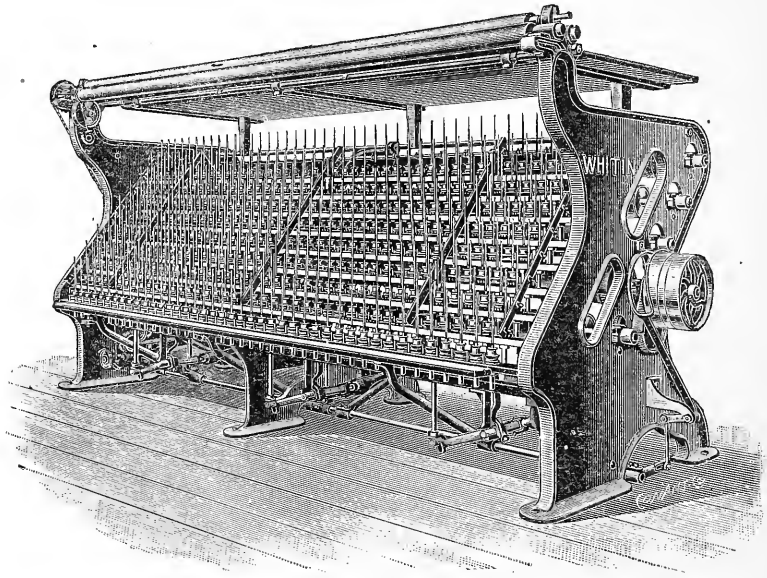


Fig. 23.

Short Chain. The difference between Long and Short chain is as follows: the short chain, varying from 400 to 800 yards in length, when received from the dye vat, is drawn through a sizing trough and sized in bulk, and then placed on the loom beam, instead of being beamed and then sized on the slasher. It is a more costly process than the long chain, and the results are not as good unless the yarn is brushed during the beaming process.

Brushing lays the fibers, and the resulting rounded yarn will then weave a nearly perfect cloth. This method is used in making fine chambrays. This is unlike the old-fashioned hand-dressing,

where the beam and creel were far apart, the dresser applying cold size with long flat brushes; the yarn being brushed on both sides and wound on the beam. In the short-chain system (used for fine colored yarns, where cost is secondary) when hand brushing, the dresser draws two long hand brushes over the yarn from the beam to the creel, while the yarn is run over on the beam. The yarn passes from the ball around the friction rolls, over the split

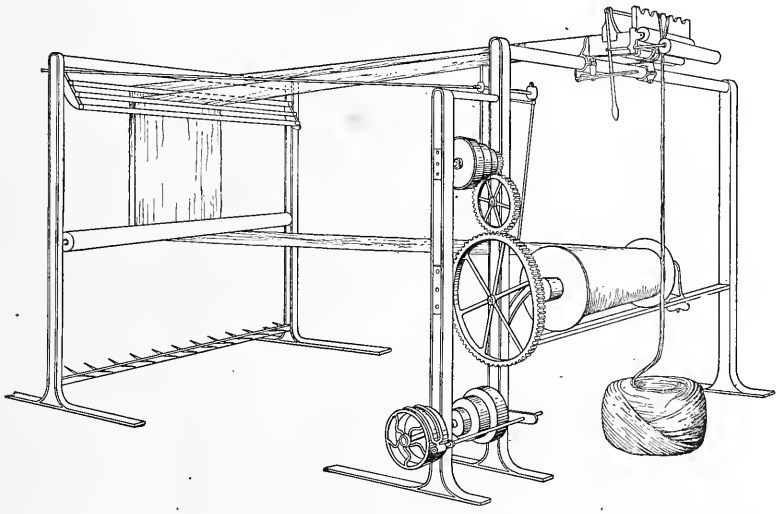


Fig. 24.

rods, through the comb on to the beam. The adding of a brush to the slasher performs the work in almost as finished a manner as hand-dressing, besides producing more warp in the same time. Fig. 24 shows a hand or short-chain dressing machine.

THE SLASHER.

In this machine the sizing compound is placed on the warp yarn, thus strengthening the yarn and laying the fibers. When sized, the yarn is better able to stand the oscillations of the reed during the weaving process. Weight may also be added to the yarn in this machine by means of the sizing compound. It is necessary to size all ordinary single yarns, but ply yarns very seldom require this unless heavily sleyed, that is, made into a fabric having a large number of threads and picks per inch. In making fine grades of goods having a large number of picks,

the yarn should be stronger and greater skill displayed in sizing the warps. A point to be emphasized is that one-half the weaving is practically done in the preparing room, for no amount of skill expended afterwards will produce good results from a poorly sized warp. The weaver is often blamed for not producing quantity and quality, although the fault lies with the preparers. If the slasher tender allows his machine to stop for an undue length of time, so that the yarn is burned a little, or the size is caked on the yarn, or if he carelessly allows the size to become thin, it is impossible to expect good results from the warp. It pays to have skilled labor in a dressing room.

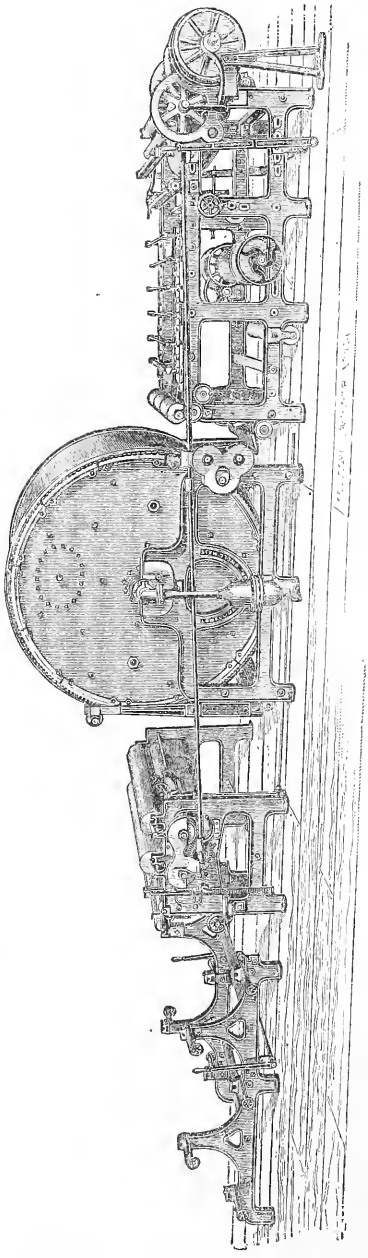


Fig. 25.

Creels. There are two kinds of creels for slashers, the upright and the horizontal. Both are for the purpose of holding the back beams. The upright creel saves floor space, as the beams are placed one above the other. The horizontal stretches out behind the machine, and the beams are placed one behind the other. The latter is considered the better, as the attendant can get at the beams more readily. Sometimes there is a slight difference in the width of back beams; when such is the case, the widest beam must of necessity be placed nearest the machine, and

the narrowest farthest from the machine. If this is not done, the ends from the widest pass outside the flanges of the narrowest beam, or crowd as they pass through the squeeze rolls, thus lifting the rolls, and preventing the rest of the warp from being thoroughly squeezed. (See Figs. 26 and 27.)

Size Box. The yarn passes from the creel over an iron roller into the size box. There are two kinds of size boxes, the

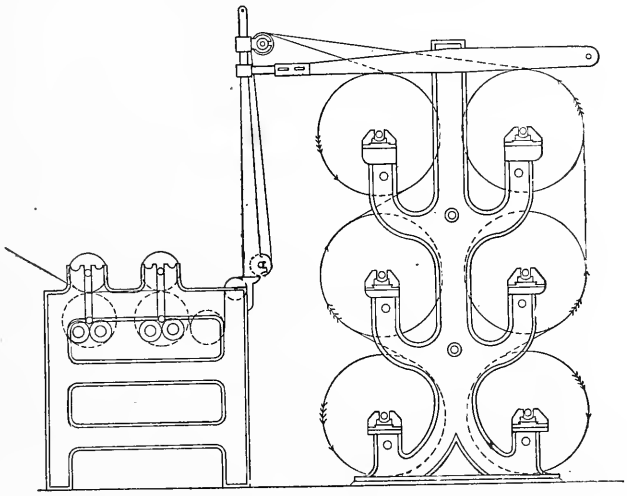


Fig. 26.

plain and jacketed. The plain box is the one in which the size is heated and boiled by means of a perforated pipe that is in the box. This pipe discharges the steam into the size.

The jacketed size box has a steam chamber under and around

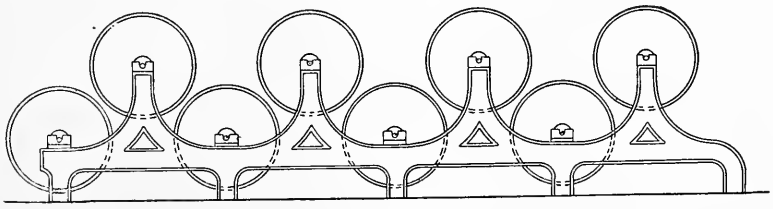


Fig. 27.

it, so that the size can be heated without steam being discharged into the mixture. This jacketed size box also has a perforated pipe inside, so that either method can be used.

Both the above systems have their advantages. It is claimed that with the jacketed vat there is no possibility of steam getting into the size and thereby weakening it. Careless slasher tenders often allow the size to become weak, thus causing soft-dressed warps. Those who prefer the perforated pipe say that so little condensed steam enters the size, it is not weakened to any injurious extent; that the size can be boiled ten or fifteen minutes

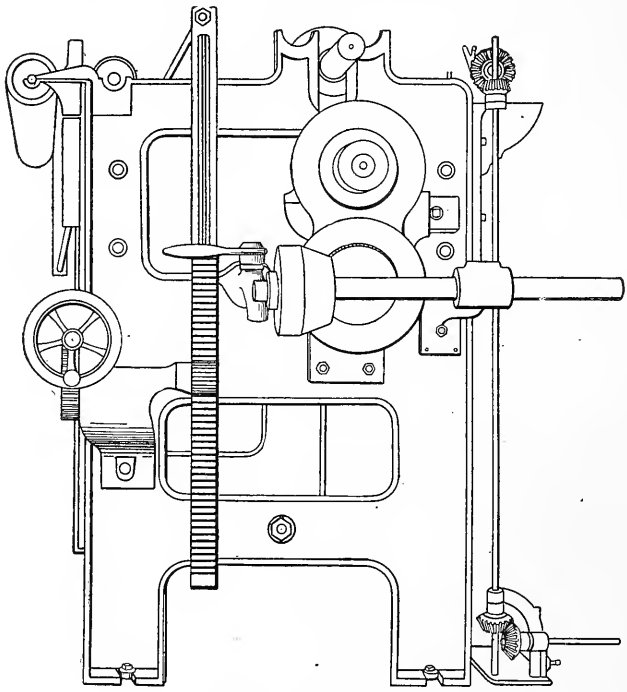
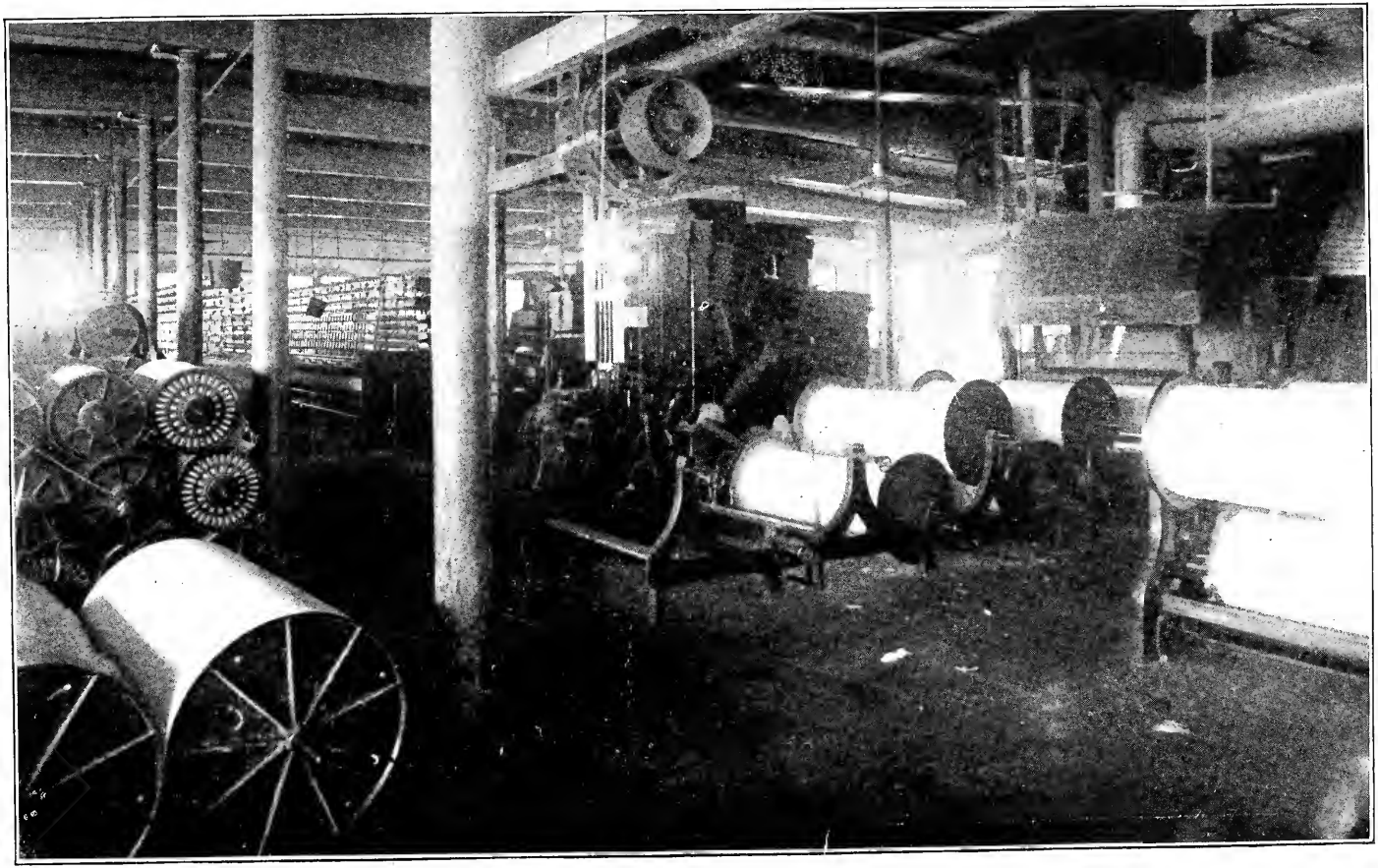


Fig. 28. (See also Fig. 38.)

quicker than with the jacketed vat, thus effecting a considerable saving; and that the size vat can be more readily cleansed. See Fig. 28.

Immersion Roller. The yarn passes under an immersion roller, which is made of copper and arranged so that it can be raised or lowered, according to the amount of size desired on the yarn. If the roller is low in the vat, thereby having more of its surface in the size, it will take longer for the yarn to pass through the size, and it will absorb more.



75 H. P. INDUCTION MOTOR DRIVING TWISTERS AND SLASHERS
Dwight Mfg. Co.

Squeeze Rolls. The yarn on leaving the size box passes through two sets of squeeze rolls. There are some instances where only one set of rolls is used, but this method does not give good results, even with fine yarn, while with coarse yarn the results are very poor. The two lower rolls of each set are copper; the roll on the top of each copper roll is solid iron. The solid rolls should be covered with an especially prepared flannel cloth, which is almost a felt. These coverings should be taken off once every week and allowed to soak in water for a day or two, from Saturday until Monday morning, for instance. Flannel cloths make the best coverings, because they allow the yarn to sink into the cloth to a slight extent, whereas cotton cloths become hard and glazed with the size, and not only tend to flatten the yarn, but cause it to be drawn through the rolls before it is thoroughly squeezed of unnecessary size. It is beneficial, also, to wash the rolls every time the machine is stopped, that is, at noontime and evening. A good way to do this is to take the regulation watering can, and pour the water on the rolls while the machine is running for the last two or three turns.

These are simple matters, but they make the slasher tender more efficient.

Two sets of squeeze rolls are advantageous because the second set act as finishers, and yield a cleaner yarn. The machine can be run at a little higher speed, because there is less chance of excessive size adhering to the yarn. The yarn will also be dryer as it reaches the loom beam, because there has been less size to dry. See Fig. 25.

Cylinders. From the squeeze rolls the yarn passes around the cylinder or cylinders. Opinions vary as to whether one cylinder or two give the best results. As the purpose of the cylinder is to dry the yarn after it has been sized, it is claimed by some that by the use of two cylinders, owing to the increased drying space, there is a better chance for this to be accomplished. For coarse counts of yarn, all the drying space that can be obtained is necessary, or the result is a damp warp, which tends to mildew if kept in stock for any length of time. There are others who prefer one large cylinder, on account of less parts to look after; but space in the mill is to a great extent the deciding point.

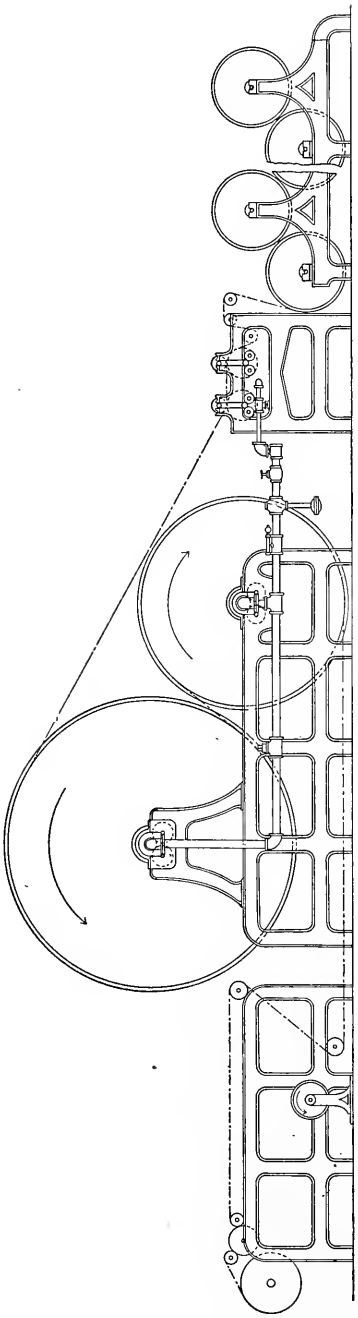


Fig. 29.

The cylinders are of various sizes, the double cylinders being 8 and 6 feet in diameter, 7 and 5 feet, 6 and 4 feet; the single cylinder from 8 to 12 feet in diameter, the width being determined by demand. For general fine work the single cylinder is usually considered better. The cylinders are heated by exhaust steam or live steam from the boiler; as both methods give good results, the cost usually decides this point. See Fig. 29.

Reducing Valve. In addition to a gage, a reducing valve is usually attached to a slasher. When the steam comes directly from the boilers it is generally necessary to reduce the pressure before entering the cylinder. The pressure in the cylinder varies from 4 to 10 pounds; 6 pounds is the average pressure used. Warps of comparatively few ends might require even less than this, owing to the small amount of dampness on the cylinder. With a heavy yarn of a greater number of ends a larger amount of steam is necessary. A greater pressure is also desirable when the yarn is heavily weighted; that is, loaded with heavy size, as will be explained later. See Fig. 31.

Steam Trap. A trap is attached to the steam outlet, and

should work perfectly to prevent the loss of steam. If the slasher is run at high speed, more steam will be used to thoroughly dry the

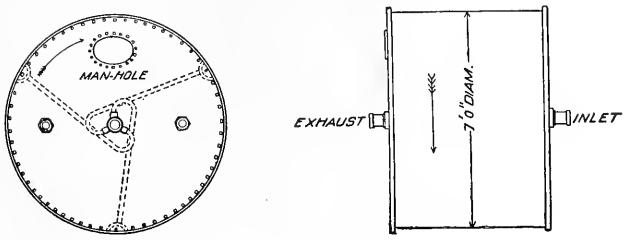


Fig. 30.

yarn than is necessary with ordinary speed. A few more yards of warp can be sized and dried if this extra steam is used, but it is not economical to gain even a warp in two or three days at the expense of greater cost. The inside of the cylinder is fitted with drip pans, which catch the condensed steam and convey it to the outlet. There are generally three of these pans fixed at equal distances apart, and extending the full width of the cylinder. They have a slight incline, and pipes in the form of the letter S running from the lower end convey the water to the outlet. (See Fig. 32.)

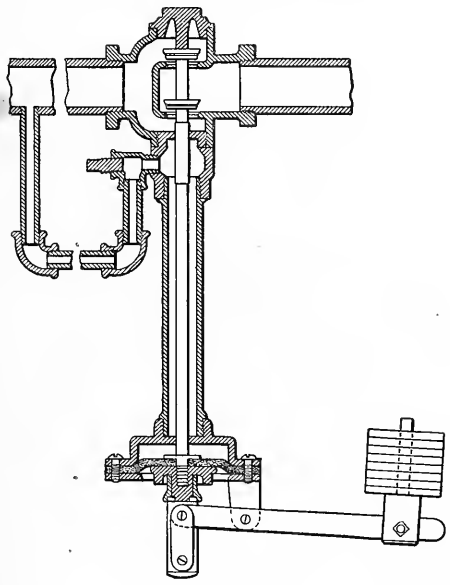


Fig. 31.

Vacuum Valve. The cylinders are also fitted with a vacuum valve, and frequently the slasher tender has serious trouble by neglecting it. Sometimes this valve becomes fouled, and the cylinder collapses; for if the valve does not allow air to enter the cylinder after the steam is shut off, a vacuum is formed and the thin copper sheeting is not capable of resisting the external pressure.

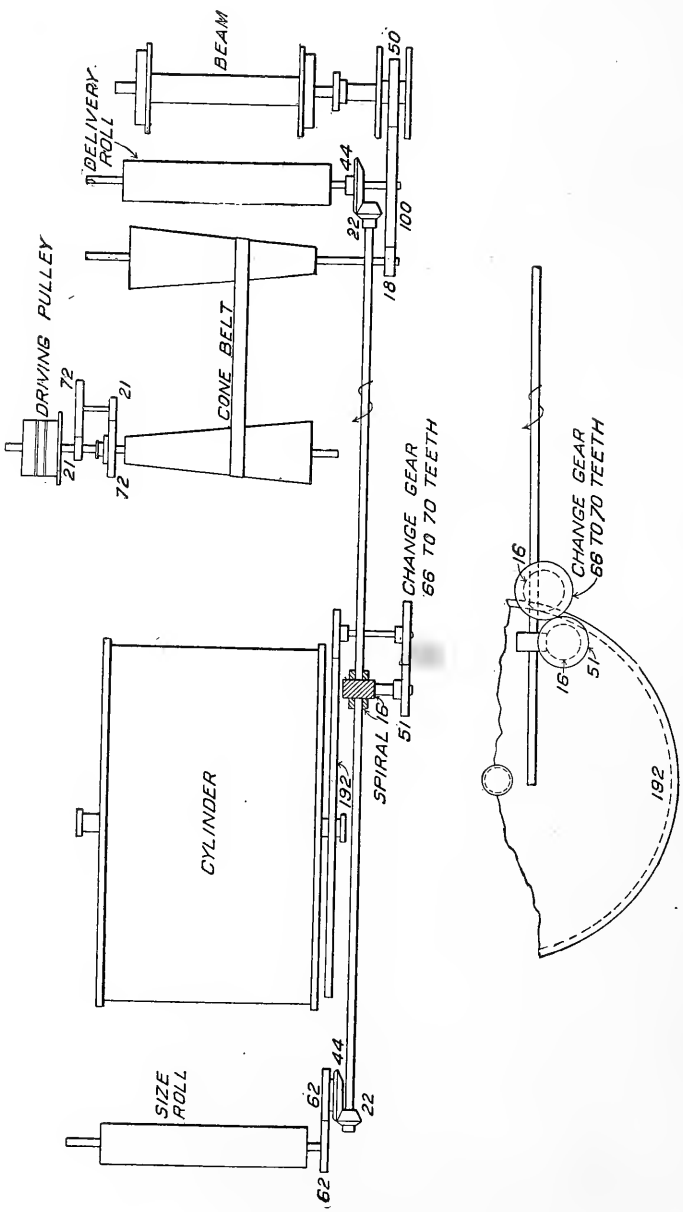

BEAM
DELIVERY ROLL
DRIVING PULLEY
CONE BELT
CHANGE GEAR 66 TO 70 TEETH
SPIRAL
CYLINDER
SIZE ROLL
50
44
22
100
18
72
21
27
192
16
51
62

Fig. 33.

Gear Drive. It is becoming a recognized fact that to have the best results, namely, elasticity in the yarn, and less breakage, the cylinder should be fitted with a gear drive, so that it will be driven at the same speed as the rest of the machine, but without gaining its motion from the pull of the yarn, as is common in some mills. The elasticity of the yarn should be preserved, so far

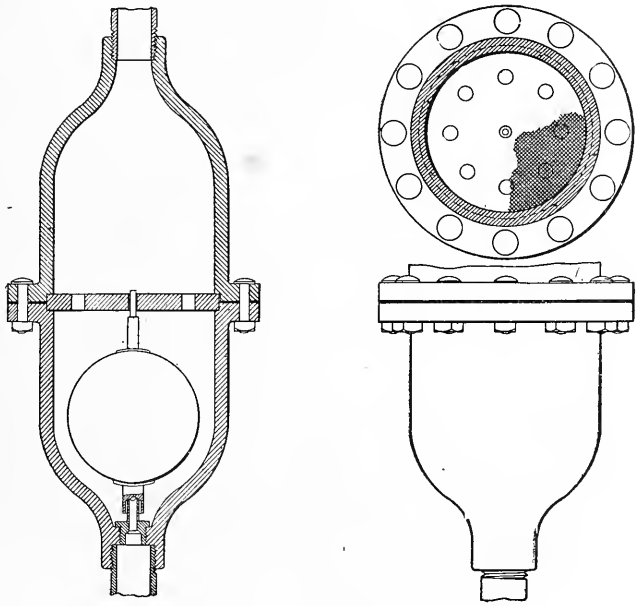


Fig. 32.

as is possible, in every process through which it passes. Yarn that has been properly handled is brighter, of greater value, and weaves better because it yields somewhat to the strain put upon it. Fig. 33.

The Fan. This is an essential feature of the slasher, and as it is a preventative of greater steam pressure it should not be lost sight of. The fan helps to dry the yarn as it passes around it, and also blows away the steam that issues from the drying yarn. Without the fan, or with it stopped, the steam follows the yarn, which is likely to be damp when it reaches the loom beam. The yarn passes from the cylinder, around the fan and up over the measuring roll, as will be explained later.

Split Rods. From the measuring roll the yarn passes around

the split or separating rods. The purpose of these rods is to separate the threads before they pass on to the beam. After being sized, the ends cling together, and it is necessary to separate them, otherwise the weaver will have difficulty in weaving the warp, because of the ends clinging together. The number of rods is determined by the number of back beams, one rod less than the number of beams; thus with 6 beams 5 rods are required. The rod nearest the cylinder is the largest, and divides the ends as nearly as possible into two equal parts. A glance at the sketch, Fig. 33, will show the method of placing the tapes for the dividing rods. No. 1 is the thick rod set nearest the cylinder; No. 3 is the first thin rod on the top; No. 2, first thin rod at the bottom; No. 4, second thin rod on the bottom. The above is the order of laying in the tapes after a set has been started, No. 1 tape passing through the size box first, the rest following in the order given. This order is changed when starting up a new set of beams, as explained later. A careful slasher tender will often place the tapes in the yarn, because they keep the threads straight, and better weaving is the result. From the split rods the yarn passes through an expansion comb, over a solid iron roller, around the tension roller, over a second solid roll, and on to the beam. This

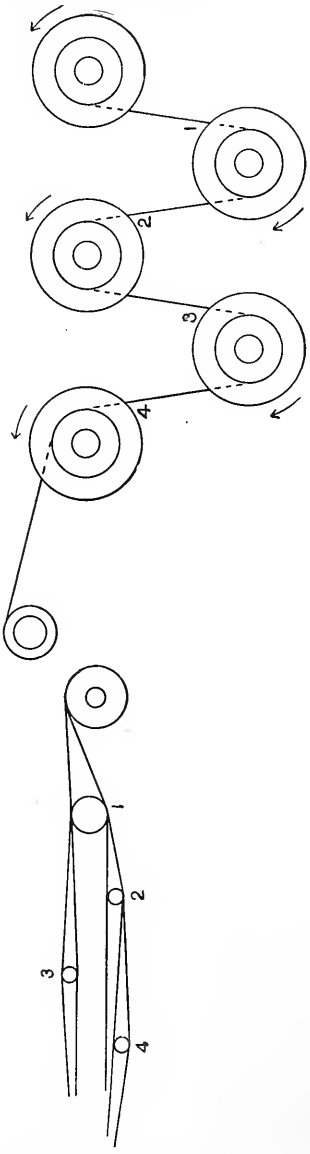


Fig. 34.

expansion comb is the same as that on the warper, and has a ratchet at the end which can be driven by a pawl from the driving shaft. If there are several cuts on the back beams after the loom beam has been filled to the edge of the flanges, instead of making a small warp, which is as expensive as a large one, in the drawing-in or twisting process, the width of the comb is gradually decreased by means of the ratchet, and the extra cuts are placed on the full beam without damage to the yarn. The extra length of warp is built up in a narrower space at every turn of the beam. This manner of disposing of warp cannot be practised if the cloth is to be made in a short time, as small warps are then run in order to fill more looms. (Fig. 34.)

Tension Roll. The tension roll, as its name implies, adds to the tension of the yarn; the larger the number of ends, the greater the tension required. The tension is obtained by wrapping layers of cloth around the roller, for by increasing the circumference the tension is increased.

Beam Drive. The beam is driven by friction, and the tender should use good judgment in the amount of friction applied. Too much friction tends to strain the yarn, and breaks many ends; while insufficient friction makes a soft beam, which is a cause of uneven cloth, the warp not weaving as well as when firmly made. The head drive is furnished with a hand wheel, so that the amount of friction can be readily changed. The amount applied is a trifle more than is actually necessary to take up the yarn delivered from the tension roll; this tends to make a tight warp without undue strain on the yarn. Failing to attend to this is often the cause of burnt yarn, also stiff or oversized warps, because the yarn is on the cylinder or in the size box too long. (See Fig. 35.)

Press Roll. Some slasher tenders allow the machine to run for a short time on a new warp before the press roll has been placed in position. This often causes a poor section of warp near the bottom of the beam. The same defect is found if the regulation of the friction is delayed too long. On account of this careless work, the warp yarn is run loosely on the beam, thus forming several soft layers. The next few layers sink into these soft layers, and owing to this, warps have had to be cut out and used for piece threads. A roll that is very valuable is known as the

extending press roll. This is so arranged that it can be used for beams of several different widths, thus ensuring an even warp. When the one-piece roll is used, it often happens that it does not fit between the beam flanges, but leaves a small space on one side. If such is the case, the selvedge threads are not pressed on that side, and therefore build up higher than the rest of the yarn. Before the beam is filled, these side ends are built up to the edge of the flange, and the warp must be doffed then, or the threads may be slipped over the flange. They are then likely to become tangled and broken, and afterward the selvedge will never weave properly.

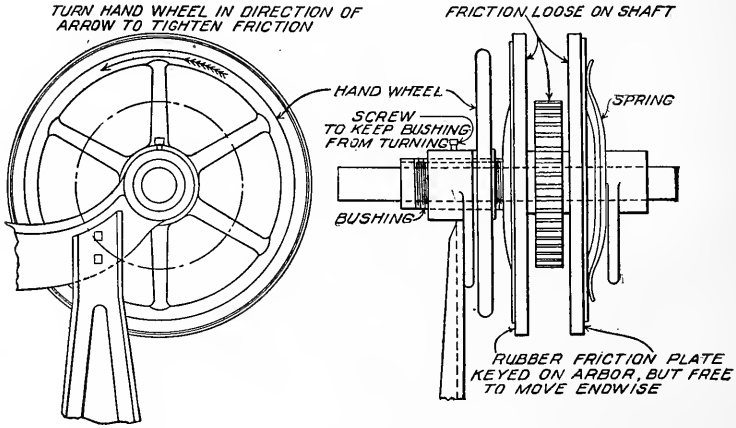

TURN HAND WHEEL IN DIRECTION OF ARROW TO TIGHTEN FRICTION
FRICTION LOOSE ON SHAFT
HAND WHEEL
SCREW TO KEEP BUSHING FROM TURNING
SPRING
BUSHING
RUBBER FRICTION PLATE KEYED ON ARBOR, BUT FREE TO MOVE ENDWISE

Fig. 35.

The press roll is placed below the beam and is supported on two lever arms, which can be raised or lowered to suit the beam. The weights placed on a lever connected to the supporting shaft are regulated to suit the pressure required on the press roll.

Cone Drive. In addition to the regular straight drive for the slasher, two cone pulleys are placed on the inside of the machine near the head, and the speed can be increased or diminished by means of a traveling shipper placed on a worm. The speed is gradually decreased as the warp increases in size, for if this is not attended to, the yarn travels at too great a speed through the size,

and a poor warp is the result. If a very heavy warp is being sized, the speed can be reduced by means of this drive, so that the yarn has a longer time to dry as it passes around the cylinder.

Slow Motion. There is also a slow-motion drive, fixed on the same principles as that on the warper. This is generally used when putting in the split rods and also when cutting off laps. Laps are ends that have broken and wrapped around the back beams or the squeeze rolls.

Calculations for Measuring Roll and Bell Gear. In order to show the weaver where to cut the cloth when it is woven, cut marks are placed at equal distances on the yarn as it leaves the size box. A marker passes through a reservoir in which a certain color of aniline ink has been placed. This marker is connected directly with the measuring motion and the clock. The particular gear that imparts motion to the marker is called the bell gear, because it causes a bell to ring when the marker prints the colored line on the yarn. The clock connected with this motion denotes the number of cuts placed on the beam. The stud gear is on an extended stud, and between the gear and the nut on the end of the stud is a spiral spring. The spring keeps the gear in mesh with the train, but when a warp is finished and it is desired to turn the motion back on the cut marker, it can be done without turning the measuring roller, as this would tender the yarn that was around the roller. The setting of the motion is accomplished after drawing out the stud gear on the extended stud.

Rule. Multiply the circumference of the measuring roll in inches by the stud gear times the bell gear, and divide the product by 36 inches, which gives a constant number, and that number divided by the yards required will give the change gear.

Suppose the circumference of the measuring roll is 18 inches, the stud gear contains 80 teeth, bell gear 50, change gear on the end of measuring roll 40. This combination of gears gives 50 yards per cut.

To find the stud gear required to give an odd number of yards, proceed as follows: with a 40-tooth change gear each 8 teeth on the stud gear will give 5 yards, so that changing the stud

gear for one with 72 or 88 teeth will give 45 or 55 yards to a cut.

Example, using the above rule to find a standard number.

$$\frac{\text{Circum. of Roll. } 18 \times \text{Stud Gear. } 80 \times \text{Bell Gear. } 50}{\text{Inches. } 36} = 2{,}000 = \text{Constant.}$$

$$\frac{\text{Constant. } 2{,}000}{\text{Change Gear. } 40} = 50 \text{ yards per cut.}$$

The stud gear is often changed to get an odd number of yards, but the same rule is followed.

By changing the stud gear to 72, thus having the following train of gears, 72 stud gear, 50 bell, 18 inches circumference of roll, a standard is obtained of 1,800 yards. This standard gives a wider range than the first standard of 2,000. We can obtain 50 yards with a 36 change gear, or 36 yards with a 50 gear. Also 60 yards with a 30 gear, or 30 yards with a 60 gear. The smaller the change gear, the greater the number of yards in a cut. The larger the gear, the smaller the number of yards.

$$\frac{\text{Circum. of Roll. } 18 \times \text{Stud Gear. } 72 \times \text{Bell Gear. } 50}{\text{Inches. } 36} = 1{,}800 = \text{Standard Number.}$$

$$\frac{\text{Constant. } 1{,}800}{\text{Change Gear. } 36} = 50 \text{ yards per cut.}$$

Aniline inks are used for making cut marks because they retain their brilliancy and do not stain the cylinder to any great extent. (See Fig. 36.)

SIZING.

Sizing is the immersion of the yarn in a prepared size mixture. The ingredients of this mixture are boiled and placed in a size box; as the yarn is drawn through the box, the size adheres to it. This is an essential feature in warp preparation, for however good the yarn, or however carefully the preceding processes may have been carried out, poor results follow neglect in sizing. Thought must be given to the quality and quantity of the ingre-

dients that form the size for the various kinds of yarn and the resulting fabrics. At the present time there is not as much skill required of the slasher tender as formerly in this work, because of the numerous patented mixtures. A careful overseer, however, who desires to know what he is using, will study the component parts that form a good size. This often results in economy, for local needs are best known by a wide-awake man. As already

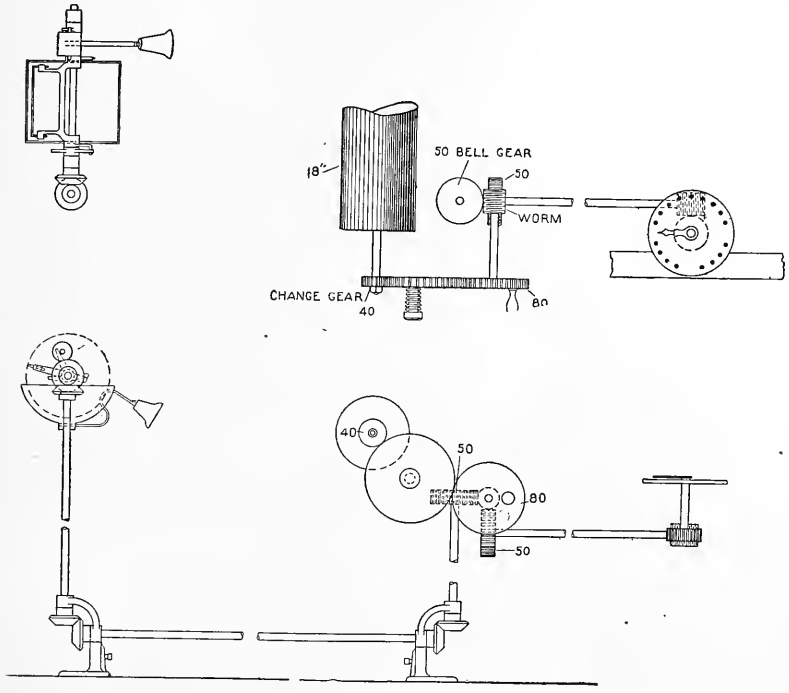


Fig. 36.

stated, single yarns must be sized in order to strengthen them. Insufficient size makes soft warps, which require very delicate treatment from the weaver, and which frequently cannot be woven; this also applies to a stiff warp, or one that has too much size on it. A slasher tender can so accustom his fingers to the feel of the yarn that he can readily tell the strength of the size. The machine should not be entirely stopped unless absolutely necessary, because stopping causes the size to cake on the yarn. This must be brushed off when the yarn is passing on to the beam.

A soft yarn results from brushing, and many ends break as they near the split rods. Unless the stiff place has been repaired by the slasher tender the weaver has great difficulty in making good cloth from this part of the warp.

In some mills the size kettle is connected to pumps, which pump the size into the vat. In some a rotary pump is constantly feeding and taking away size. Both of these features are excellent. In other places the size is in a kettle placed above the machine, and the simple opening of a faucet releases it when required. Again, in some mills the size is carried in pails from the kettle to the vat. In the latter case when pouring the size into the box, unless care is taken, lumps are sure to adhere to the yarn, with the result already described. There have been cases in which tenders who were running tablecloth warps poured the size on the squeeze rolls, without a thought or care; and as brushes were not used, great blotches of size were caked on the yarn, and some of the warps were thrown away.

The careful tender must see that the size does not get above the boiling point, for he knows that if it does the size will sputter, and little blebs or patches will appear on the yarn when it goes on the beam.

There are three distinct degrees of sizing, namely: Light, Medium and Heavy. The first is used when a solid cotton cloth is desired, especially in the finer grades. It adds a small percentage of weight to the yarn and strengthens it for the weaving process. In many cases almost all is washed out after it is woven. The second adds from 10 to 20 per cent of weight to the cloth. The third is not often used. A skilled size mixer is able to make a preparation that will deceive even experts when handling the cloth; he may readily believe that the cloth is not weighted beyond what appears to be the lightest size, when the cloth in question contains weighting ingredients to the amount of 15 per cent.

Sizing ingredients are divided into several classes.

1. Strengthening compounds
2. Softening compounds
3. Weighting compounds
4. Antiseptic

Strengthening. Potato starch or farino, dextrin or British gum, wheat flour, maize, sago, rice and tapioca. Potato starch is by far the best.

Softening. Tallow, bone grease, cocoanut oil, palm oil, Japan wax, beeswax, paraffin wax, glycerin, dulcine, Irish moss and soap.

Weighting. China clay, French chalk or silicate of magnesia, sulphate of magnesia or Epsom salts.

Antiseptic. To prevent mildew. Chloride of zinc.

Ultramarine. This blue is used for making less evident the yellow shade of the yarn; the proportion is one ounce to about five sacks of flour.

The value of a size is determined by its adhesive and strength-giving qualities.

FORMULAS.

Light Size. A good light size may be made up as follows:

40 to 50 pounds of potato starch
100 to 110 gallons of water
2 to 3 pounds of tallow
3 to 5 ounces of chloride of zinc

This would add 3 to 5 per cent in weight.

There are no patent compounds that are as good as a mixture of the separate ingredients named above, however much they may be praised. For light sizing the best ingredients should be used. The above have been used from a very early date as sizing compounds, and are now very generally used.

Medium.

100 gallons of water
120 pounds of potato starch
60 pounds of dextrin
40 pounds of Epsom salts
60 pounds of China clay
2½ pounds chloride of zinc
3 quarts bleached palm oil

The above is for the purpose of making the cloth feel heavier than it would if made from pure cotton; the cloth can also be produced at less cost.

Heavy. This formula is governed by the judgment of the overseer, and by the requirements. It is well to add a little blue to each batch of size, for it takes off the yellowish tint that would

otherwise appear on the yarn. The fatty substances not only soften the yarn, but lubricate the eyes of the harnesses.

The above formulas are general, and by adding the following the weight will be increased, as indicated.

To add 10 per cent of weight:

125 gallons of water
88 pounds of cornstarch (Pearl)
1½ pounds of tallow
2 ounces of Glauber's salts
2 ounces aniline blue
1 pint turpentine
Sufficient for 216 cuts of 66 yards, 1,616 ends, 22's yarn.

To add 10 per cent weight:

52 pounds cornstarch
4 pounds dressing (Scott's size)
1 pound tallow
1½ ounces blue
1½ ounces Glauber's salts
1 pint turpentine
90 gallons water
150 cuts, 66 yards, 1,616 ends, 22's yarn.

To add 15 per cent weight:

175 gallons water
112 pounds cornstarch
1½ pounds tallow
2 ounces salts
2 ounces blue
1 pint turpentine
190 cuts, 55 yards, 1,700 ends, 16's yarn.

Turpentine is considered one of the best ingredients for preventing mice or rats from eating cloth; it is also to a small degree antiseptic.

Size Kettle. There are different makes of size kettles; the jacketed kettle is claimed to be the better, while the kettle with the perforated steam pipe has many supporters. In the latter, however, the size boils more quickly and shows less tendency to cake at the bottom of the kettle.

A size kettle is fitted with agitators, to mix up the ingredients. These agitators are constantly moving so that the size is kept free from lumps; they turn from 15 to 20 revolutions per minute. The more the size is agitated the thinner it becomes;

hence the time when the size is thoroughly boiled must be watched for. Cornstarch requires more boiling than any other ingredient, and the longer it is boiled the better it becomes.

The starch is placed in the required amount of water, and agitated for 15 minutes; when it starts to boil, the other ingredients are added. Flour requires a considerable amount of soaking before it can be profitably used, usually from seven days to three or four weeks.

Colored Yarns. For about 25 or 30 counts of yarn use 100 gallons of water, 20 pounds of potato starch, 5 to 6 pounds of stearin, 5 to 6 pounds bleached palm oil, $\frac{1}{2}$ pound beeswax, $\frac{1}{2}$ pound spermaceti, and 3 to 4 ounces chloride of zinc. The wax and spermaceti assist in making a smooth yarn; each alone of sufficient quantity would have a tendency to harden the yarn. The stearin, tallow and oil act as softeners.

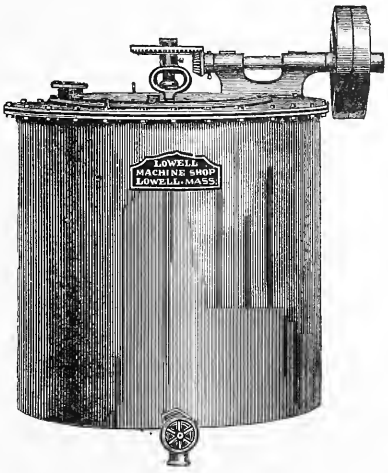


Fig. 37.

Bleached Goods. If the yarn to be sized is to be made into a cloth that must go through a bleaching process, wax should not be added, because the bleaching powder cannot penetrate the wax, and gray spots will appear on the cloth. Use 50 pounds of starch, $2\frac{1}{2}$ pounds tallow, and 100 gallons of water. Some dressers use soap, but it is not advisable, as it bubbles, and also requires some ingredient to prevent the yarn from sticking to the cylinder. The excellence of potato starch and its extensive use is due to the fact that it does not leave a harsh feeling on the cloth, or at least not to the extent that other starches do. For this reason it is given in the formulas.

If there is any tendency for the colors to bleed or run, cold size should be used, made slightly thinner than usual, to prevent the possibility of lumps adhering to the yarn. But if the colors are fast, the yarn can safely be run through hot size. Occasionally

colored yarns are sized first, short-chain system, then run through the slasher over the squeeze roll at the same time that the rest of the yarn is passing through the size.

Flour is used in some mills in place of potato starch on account of its fine adhesive qualities, but it is not extensively used, because of its great tendency to attract moisture, which causes mildew. As before stated, it must be steeped in water for several days before using.

Two or more ingredients having similar properties are used in order to lessen the cost. It often happens that by using a little of a second ingredient there is a slight saving in the cost of the size, and yet a good result is obtained, because one helps the other, where alone one would probably give too much weight or softness to the yarn.

SIZING COMPOUNDS.

Vegetable. *Dextrin* possesses the same chemical composition as starch; gives a harsh feeling to the cloth.

Wheat Flour, produced from wheat, should be free from color, bad odors and acidity. When exposed in a damp place it quickly mildews; it contains a large proportion of gluten.

Potato Starch, or *Farino*, from the potato. It makes a stiff paste.

Maize, or *Corn Flour*, has great stiffening qualities; expensive, and requires additional softening.

Rice, not much used for gray cloths; gives hard feeling and is expensive.

Sago, from sago palm, gives very harsh feeling and requires but little to make size, though plenty of fatty matter to soften, particularly cocoanut oil, 1 ounce to 1 gallon of size. It soon becomes watery.

Tapioca has little starchy matter.

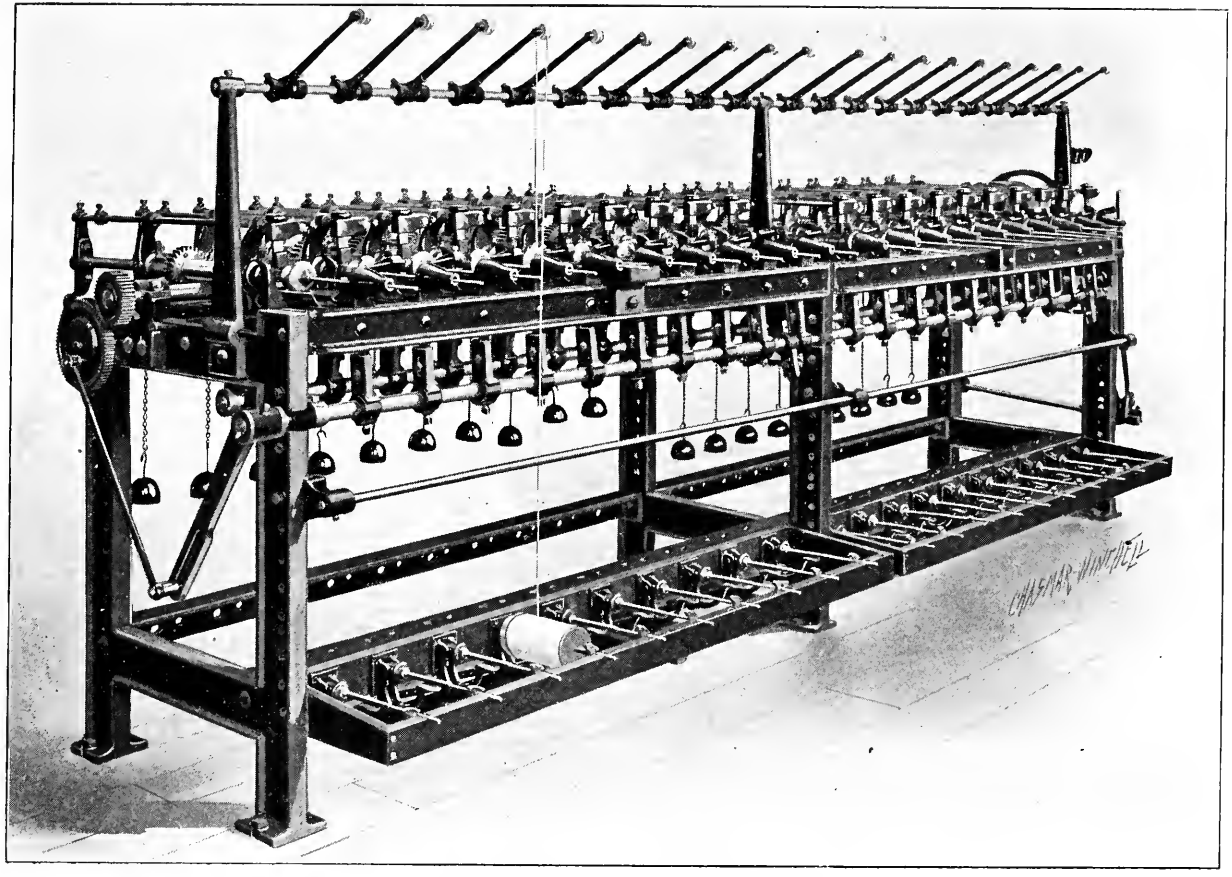
Fatty Matter. *Tallow.* Good tallow is white. Should be used in the proportion of about 8 pounds to 1 sack of flour.

Bone Grease, cheapest, but has a tendency to become rancid.

Cocoanut Oil, used principally in sago sizing; becomes rancid.

Bleached Palm Oil, next to tallow for valuable qualities; also used in sago sizing.

Castor Oil, sometimes used with tallow.



CROMPTON & KNOWLES COP WINDER

Waxes. *Japan* and *American* waxes are soft, brittle, fatty substances.

Paraffin Wax is not saponifiable by alkalies; that is, cannot afterwards be removed from the cloth during the bleaching process.

Glycerin gives a soft feeling to the cloth, especially when weighted with China clay. The quantity used should be limited, as it becomes sticky and keeps the yarn moist.

Dulcine, a mixture of glycerin, gum and Chinese wax.

Irish Moss contains a large amount of vegetable mucilage.

Soaps have a tendency to make the size lumpy.

Mineral as weight givers. *China Clay*, produced by the disintegration of feldspar; it is best when milk white.

French Chalk, or *Silicate of Magnesia*, has a tendency to discolor.

Sulphate of Magnesia, or *Epsom Salts*, the best cleanser, permeates the yarn; it also gives weight and should be pure.

Sulphate of Baryta gives a harsh, hard feeling, and is better for finishing.

Glauber Salts; same as Epsom Salts.

Chloride of Calcium, used with chloride of magnesium for adulteration; must not be used alone, as it keeps the yarn moist.

Antiseptic. *Chloride of Zinc* is the antiseptic most commonly used, and kills the mildew germs.

Chloride of Magnesium should not be used in goods that are to be calendered.

Silicate of Soda tends to make the cloth tender.

STARTING UP A NEW SET OF BEAMS.

Measure the width between the beam heads, then place the widest beam in the creel nearest the machine, and the narrowest at the back. In the meantime raise the top squeeze rolls from the bottom rolls, and also raise the immersion roll in the size box. Draw over all the yarn from the beams to the first one, tying the yarn to what has been left from the last warp. As soon as the knots are through the rolls, lower the squeeze rolls and drop the immersion roll into the size. Then take the striking comb, which is a coarse comb made especially for the work, and fix it on the edge of the size box. The comb will divide the yarn into strings or divisions of seven or eight threads each. Run this way for two

or three yards, and then take off the comb. In some mills the tapes for the split rods are placed between the beams before the machine is started, the length of yarn run through the striking comb being just the length from the comb to the first tape. This method saves two or three yards of yarn. When the yarn has been run through the machine until the knots come to the split rods and expansion comb, the purpose of the striking comb is evident. The rods are taken out and the comb turned down to allow the knots to pass over. When the divided threads come

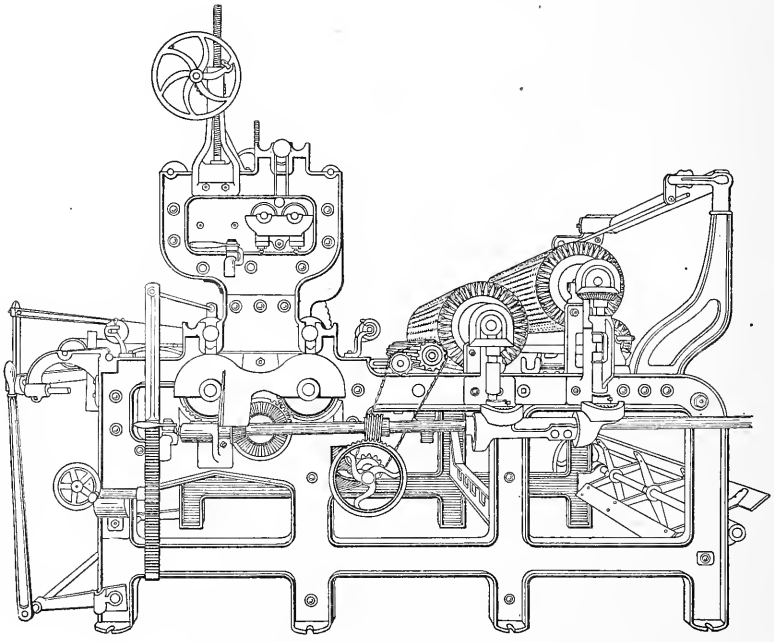


Fig. 38.

along, the comb is turned up, each division of threads being placed in one of its dents. This saves the tender the time of counting the threads that should go in each dent of the comb. If there are one or two threads more in one dent than in another they can be readily changed after the split rods are fixed. The split rods are now set where the tapes are, the first tape going over the first rod nearest the loom beam, and so on to the thick rod. After the set has been started, the opposite order of placing the tapes is used.

Now doff the last warp, secure the new beam in its place, set the clock, adjust the friction head, see that the proper quantity of size is in the box, with the immersion roll at the right depth; put on steam, set the expansion comb, and start the machine so that the yarn will be guided straight on to the beam. Now adjust the threads if there are too many in one dent.

Brushes. For fine work slashers are often fitted with brushes, which are placed between the size vat and the cylinder; clearer brushes are also set underneath the yarn. If brushes are used, the yarn produced is the nearest approach to hand-dressed warp. Brushes are an important factor when the very best results are desired. They cannot be too strongly recommended.

Leese Rods. When slashing colored goods, two leese rods in front of the expansion comb are sometimes necessary to keep the ends in the right place. This leese must be picked by hand. The usual drawing-in comb that is placed on the warp before it is doffed can be struck on the slasher, even though colored warps are being sized, the leese rods keeping the ends straight. Two size boxes are occasionally used in a colored-yarn slasher, one above the other, the top box having one set of squeeze rolls, the bottom box two sets. This method is more commonly used with a cheap dye, which has a tendency to bleed. The colored yarns are sized in the top box. The great objection to using two boxes is the slight difference in the tension on the yarn, for two sets of rolls add more tension than one set. All slashers should have a hood covering over the cylinder, and, if necessary, a fan to help in driving the steam away. The operatives do better work with this arrangement, there being less steam in the room.

The production from the slasher depends greatly upon existing conditions, so that it is almost impossible to give definite statements.

Calculations for Striped Cotton Shirtings.

Example 1.

Counts of warp yarn	50
Counts of filling yarn	50
Counts of reed	42 — 2 ends in a dent = 84 ends per inch

Width in reed practically 30 inches, including selvedges
Ends in warp 2,490
Ends for selvedges 24 — 6 double ends on each side
Total ends 2,514

Colors of warp yarn: Light Blue, Red and Bleached.
Filling bleached.
Order of colors for pattern:

60 Blue
10 White
2 Red
2 White
2 Red
2 White
2 Red
10 White
90 ends in each pattern.

60 Blue per pat. × 27 = 1,620 + 60 = 1,680 Blue
24 White per pat. × 27 = 648 + 24 = 672 White
6 Red per pat. × 27 = 162 Red
2,514

2,490 ÷ 90 = 27 patterns and 60 ends over.

To obtain an equal cloth, finish with blue stripe of 60 ends, so that the stripes near the selvedge on each side will be the same. The selvedge is white, and of the same counts as the rest of the warp.

The best appearing cloths are those that have the same stripes at each side; that is, if the warp is begun with blue it should be finished with blue. However, the dresser must follow the directions of the designer.

The method of determining the number of ends for a warp is as follows:

The width of warp in reed, the counts of reed, and the number of ends in one dent being given, the width multiplied by counts of reed and by ends in one dent gives total ends in width, aside from selvedge. Having obtained the total number of ends, add the number in a pattern; divide the total number by this, which will give the number of patterns in the warp. Then add together the number of ends of each color in one pattern, and by multiplying the number thus obtained by the total number of patterns, the result will be the total number of ends of each color required for the warp. If the color and counts of yarn for the selvedge are the same as one of the stripes, add the number of selvedge threads to that color, and make the chain or spools for

the warp according to further instructions. If, after dividing the total number of ends by the ends in one pattern, there is a remainder, as in Example No. 1, make those threads of the same color as the threads nearest the selvedge at the beginning of the pattern, and arrange the ends for the warp so that the extra threads will be near the opposite selvedge. This will finish both edges of the cloth with the same color. If, after dividing by the number of patterns, there is not a remainder, proceed as in Example No. 2.

Example No. 2.—A warp of the following layout is required: 30″ in reed, including selvedge; 30^{s} reed, 2 in a dent; 7 patterns in width, the remaining space to be made up of black selvedge ends.

Pattern 100	Red	
8	Blue	
10	Black	
4	Yellow	Red $132 \times 7 = 924$
6	Black	Black $52 \times 7 = 364 + 48 = 412$
4	White	Green $32 \times 7 = 224$
6	Black	Blue $16 \times 7 = 112$
16	Green	Yellow $14 \times 7 = 98$
10	Red	White $8 \times 7 = 56$
4	Black	1,778 total in patterns
6	Red	48 for selvedge, 24 each side
6	Yellow	1,826 total in warp
6	Red	
4	Black	
10	Red	
16	Green	
6	Black	
4	White	
6	Black	
4	Yellow	
10	Black	
8	Blue	
254	total	

If the pattern is commenced as described, it would finish with 8 blue, and a broad stripe of red on the other side of the warp; but by dividing the red stripe so that there are 50 to commence with and 50 for the finish of the pattern, the desired results are obtained; that is, a broad red stripe where two patterns are joined together, and both edges of the cloth alike. There would be the same number of ends in the pattern and warp as

there would have been had the pattern been made as first written down; but if the red stripe were not divided, a number of red threads would have to be added, in order that the cloth would finish with both edges the same. Suppose the pattern to read as follows:

No. 3		No. 4	
	10 Red		3 Yellow
	4 Black		6 Red
	6 Red		4 Black
	6 Yellow		10 Red
	6 Red		16 Green
	4 Black		6 Black
	10 Red		4 White
	16 Green		6 Black
	6 Black		4 Yellow
	4 White		10 Black
	6 Black		8 Blue
	4 Yellow		100 Red
	10 Black		8 Blue
	8 Blue		10 Black
	100 Red		4 Yellow
	8 Blue		6 Black
	10 Black		4 White
	4 Yellow		6 Black
	6 Black		16 Green
	4 White		10 Red
	6 Black		4 Black
	16 Green		6 Red
			3 Yellow
	254		254

There would be exactly the same number of patterns in the warp as in the former case, but as the rule of making an equal-sided cloth is to be followed, the number of any of the colors should be divided (the larger numbers preferred), and then the desired effect will be obtained.

Sometimes the order is given to have the main color predominate. So that No. 4 would be the order of arranging the colors to make an equal finish on both sides. This pattern will enable the student to use some of the pieces left from other patterns, as explained in pattern No. 1.

The following is the manner in which to arrange the way-chains and back-beams for this pattern:

3 chains	of 308 ends	each, Red
1 chain	of 412 ends	Black
1 chain	of 224 ends	Green
1 chain	of 98 ends	Yellow
1 chain	of 112 ends	Blue
1 chain	of 56 ends	White

When beaming these chains after they are dyed, place the red on 3 beams of 308 ends per beam, 1 beam of 412 ends for black, 1 beam of green and yellow, with the ends spaced as follows:

Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G	Y	G
4	16	6	16	8	16	6	16	8	16	6	16	8	16	6	16	8	16	6	16	8	16	6	16

Y	G	Y	G	Y
8	16	6	16	4

One beam for blue and white spaced as follows:

B	W	B	W	B	W	B	W	B	W	B	W	B	W	B
8	8	16	8	16	8	16	8	16	8	16	8	16	8	8

The beams should be placed in the slasher creel according to the manner in which it is decided to run the yarn through the size box. If the top box is used for the lightest weight of yarn, then the blue and white yarn should run through the top box and the rest through the bottom box. This will be the best method, provided all past colorings that may have adhered to the box or rollers have been removed.

Arrange the beams 1st black, 2nd, 3rd, 4th red, 5th green and yellow, 6th blue and white.

There are two methods whereby the above warp can be made. First, by spacing the spools in the creel of a beam warper, and running the yarn in the form of a stripe on the back beams for the slasher. For this method the raw stock (raw cotton) must be dyed, carded and spun, or else the yarn must be dyed in skeins and transferred by means of a skein winder to spools; the spools being placed in the creel of the warper in the following manner: The ends should be divided equally, or as equally as possible, on the back beams, so that the tension on the beams can be better gaged. The creel holds 560 ends, but we do not need that number. Five back beams for the slasher consisting of 498 ends each will give us the number, with the exception of the selvedge ends, required for the warp. The selvedge ends may be placed 3 on

each side, and run on 4 beams, but they must then be cut out so as not to run on the last beam. There will be 249 ends in each wing of the creel. Commence at the top spool in the first row, passing down to the bottom spool, then again starting at the top, so on until all the ends are drawn through the expansion reed.

Place the spools in the creel in the following order for the first 3 beams:

Blue	White	Red	White
12	2	2	2

Then take out the two red spools and replace with white spools for the last 2 beams. Repeat this order 27 times, then add 12 blue.

Proof. $12 + 2 + 2 + 2 = 18$; $18 \times 27 = 486$; and $486 + 12 = 498$. $498 \times 5 = 2{,}490$ ends in warp, exclusive of selvedge ends.

After the spools have been placed in the creel for the pattern, add the three selvedge spools on each side, draw the yarn through the reed, attach it to the beam and then fix the gears to give the required length. After the beams have been run, they are taken to the slasher and sized. The objection to the above method is that the yarn after being spun must be reeled to form skeins, then dyed and transferred from the skein to the spool. Or the stock must be dyed in the raw state, which means constant cleaning of the cards and other machinery to prevent the colors spoiling by intermixing. One advantage in this latter system is that there is very little trouble in the slasher, and the ends come through almost in the right places.

Second Method, Long-chain Process. The number of ends that are placed in a chain is governed by orders; if there are a number of warps required in which these colors can be used, whether of the same pattern or not, the number of ends in the chain should equal the capacity of the creel, or nearly so. But if a small number is required, the double worm and trumpet may be used, and two small balls made at the same time. Or, double the number of ends now required may be run (for the lesser number), and divide them on the dividing machine, with the prospect of using the other ends in a short time. The objection to dividing the chain is the time consumed, therefore this method is

only resorted to when absolutely necessary. For instance, when a sample piece of cloth is to be made, and there are some chains of the required colors in stock, the proper number of ends are separated from the chain and transferred to the back beams.

Ordinarily the pattern already given would be carried through in this manner: For the 1,680 blue run 3 chains of 560 ends each; for the white, 2 chains of 336 ends; for the red, 1 chain of 172 ends. For a larger order, make several chains of the same number of ends, and if the mill is equipped with a machine for winding a cord around the chain, wrap several of the smaller chains together, and after they are dyed, separate the several chains, beam them, and then take them to the slasher. Place the blue beams at the back, the white next, and the red beam nearest the size box. There should be no trouble in slashing this yarn, and in a good many instances there are no bad results from running all the beams through the same size box, provided the different colors are fast. If they are not fast, a separate or double size vat should be used, carrying the red through the upper box. Cold sizing, which requires great skill, might also be resorted to. Blues and some browns and other odd colors may be run successfully with whites; in fact, blues tend toward clearing whites. One size vat should be used whenever possible, even though it may cost a little more in dyeing.

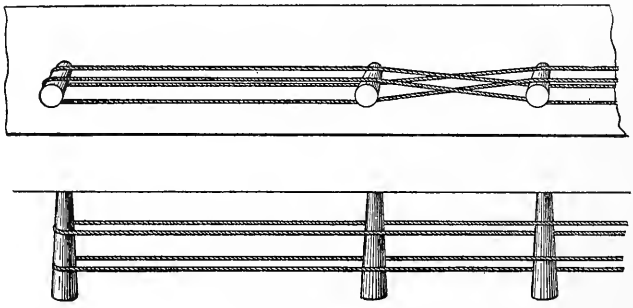
One word more in regard to warping. Some overseers do not seem to realize the necessity of using up small quantities or odd lots of yarn; the result is considerable waste, for these lots are constantly accumulating and taking up valuable space in the dressing-room; furthermore, the yarn does not increase in value when kept in such a manner.

If there is an odd chain of warp in some dusty corner, it would be better to transfer the yarn to a back beam, and if a selvedge of that particular color is required, it could be placed on the back beam behind the slasher, and the required number of ends run through, separating them at the split rods. By this method the selvedge threads are obtained without the trouble and expense of using bobbins, spools, or extra ends on the other beam. Afterward this warp can be laid aside and the ends remaining on the beam left undisturbed. If, in order to make a different pat-

tern, a few ends of another color are to be added to a stripe that is being run on the slasher, the former spare beam having enough ends of that color, it is practical and economical to use that remaining portion.

WOOLEN AND WORSTED WARP DRESSING.

It is absolutely necessary to get a correct idea of this branch of the weaving department, for if a mistake in the pattern and evenness of beaming is made here, it is almost impossible to remedy the defect. If wrong threads are used in the pattern, the right threads can be inserted when the warp goes to the loom; but those threads, whether they run from the spool or bobbin, never appear as even as the rest of the yarn; and the insertion of the extra threads cannot be called practical, for the operative's eyes must be constantly on them to prevent their coming entangled with the warp.



LEESE PINS SHOWING LEESE.

Soft beaming is undesirable at all times. The defects and subsequent losses from this process are particularly noticeable when the resulting cloth is to be piece dyed. If the threads are not beamed evenly, they weave into an uneven cloth, and when the piece is dyed it is not only rough looking but contains different shades of color. This is owing to its not having absorbed the dye equally. When a striped warp is beamed in an uneven manner, the loose threads show plainly in the woven cloth, and they often cause "seconds," or cloth of lower value. This means a loss to the mill and an investigation to fix the responsibility.

Hand-rail. In many mills the hand-rail or peg warper is

used for making pattern warps or samples. This is a convenient machine, as the work is done rapidly, but by hand, as its name implies, and little waste is made. No great amount of skill is required in making a warp on the hand rail. The main points to be observed are in the picking up of the leese, taking the same thread every time the leese is made when adding a pattern to the one already on the pegs, and keeping a constant tension on the yarn as it is carried around them.

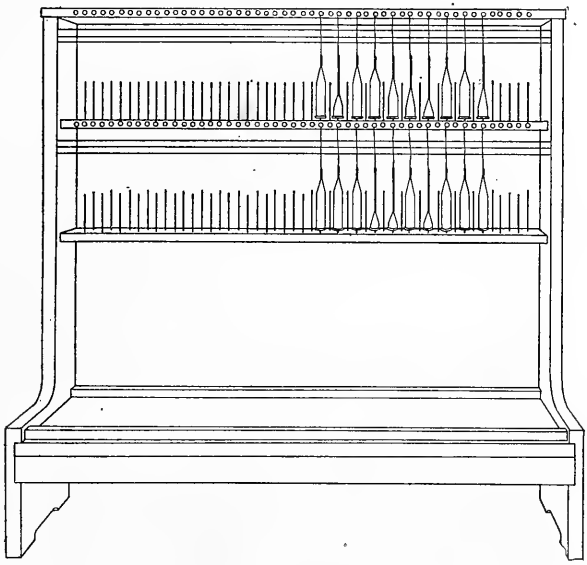


Fig. 39.

First place the bobbins in the creel (Fig. 39); the number being determined by the number of ends in a pattern.

Suppose a blanket having 500 ends in each section is to be made, one section to contain 10 patterns of 50 ends each. The following is the pattern (50 ends) to be carried out for one section (500 ends):

4 brown, 2 fawn, 1 slate, 2 brown, 1 slate, 2 fawn, 1 slate, 4 brown
1 slate, 2 fawn, 1 slate, 2 brown, 1 slate, 2 fawn, 4 brown, 4 fawn
1 slate, 1 brown, 3 fawn, 1 slate, 2 brown, 1 slate, 3 fawn, 1 brown
1 slate, 3 fawn, 20 brown threads to be added for listing

The above is a pattern for trousering, with the backing threads of brown and slate. The warp to be 12 yards in length.

Place the listing or selvedge threads on the pegs first (Fig. 40), 2 threads over and 2 under the leese pegs. Pick up the pattern, 1 thread over and 1 thread under, using the finger and thumb or a double piece of wire; always remember to keep the same order whether the first thread is placed under or over the thumb, otherwise two threads will come together when the next pattern is placed on the pegs, and will probably be drawn in on the wrong harness. After placing the threads over the leese pins, carry them around the pins set apart for the required length. Before reaching the last peg the yarn should be placed half over and half under the pegs for the footing leese. Instead of being the same as the top single leese there should be 25 ends over and 25 ends under the pegs. The footing leese indicates that there is a sufficient number of patterns on the pegs to form the required warp. From the footing leese all the yarn is passed around the last peg, and the footing leese taken again as the yarn is returned towards the single leese. This leese is also taken again, and the yarn passed around the single peg. It is best to pick the single leese just before the yarn is passed around the single peg and before the leese pegs are reached. Two patterns are now on the pegs.

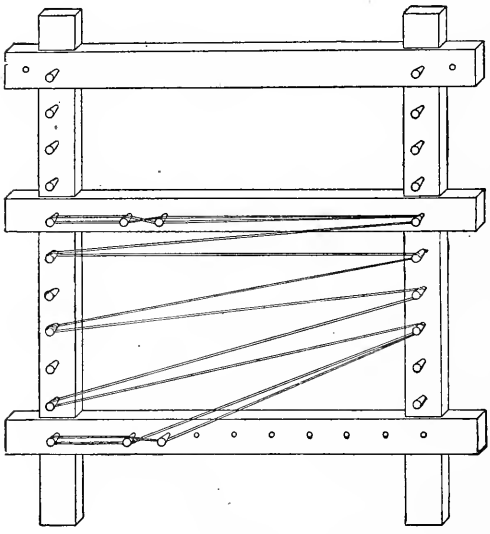


Fig. 40.

The above order should be carried out until the first section of the blanket is on the pegs, after which change the bobbins for the yarn required in the next section. After this is finished place the yarn for the third section; then add the listing threads for this side. We now have a warp of 1,500 ends in addition to the selvedges. Tie a string in the yarn in the places occupied by

the leese pegs which will retain the threads in the right order, as if they were still on the pegs. The yarn is then taken to the hand-beamer.

Hand-beamer. Hand-beamers are constructed in several ways, to suit the convenience of the operator. The yarn is stretched out between the head stock (where the beam is) and the friction end. This friction can be in the form of a rope with a weight attached, the rope being connected with a rod which has been passed through the footing leese. The rope is passed over anything that is convenient.

A stand is placed to support the beam, and to which a reed or expansion comb can be attached, the threads passing through the comb and on to the beam. After the warp is stretched out, leese rods are placed in the threads to take the place of the leese string. The above method is generally used for sample blankets, and for making short warps for cloth that is not to be duplicated.

Another method of warping which is meeting with great favor, especially in worsted mills, is the use of an ordinary beam warper, used in connection with a slasher or hot-air dresser. With this system the twister or spinning-frame spools can be placed in the warper creel, and the yarn run directly on the back beam for the slasher. The pattern is arranged in the creel. There is a saving in this system, more especially in complicated patterns. The tension on the warp is more uniform, and it is also made at one time, instead of in sections, as in the machine to be described later.

POWER WARPING.

There are four distinct operations in the dressing of warps: Spooling; Picking out the pattern and tying in the same; Sizing and Drying; Reeling and Beaming.

Spooling. The yarn is spooled from bobbins on to jack spools. The jack spool is entirely unlike any cotton spool. Instead of holding only 1 thread it has a capacity of from 40 to 50, lying side by side. It is shaped something like a cotton back beam but is much smaller. For an intricate pattern the colors are sometimes spaced on the jack spools; that is, instead of having 40 ends of one color on a spool, there are sometimes several colors.

Some spools are larger than the above, and hold 50 or more ends. While apparently a simple process, a warp may be spoiled at this

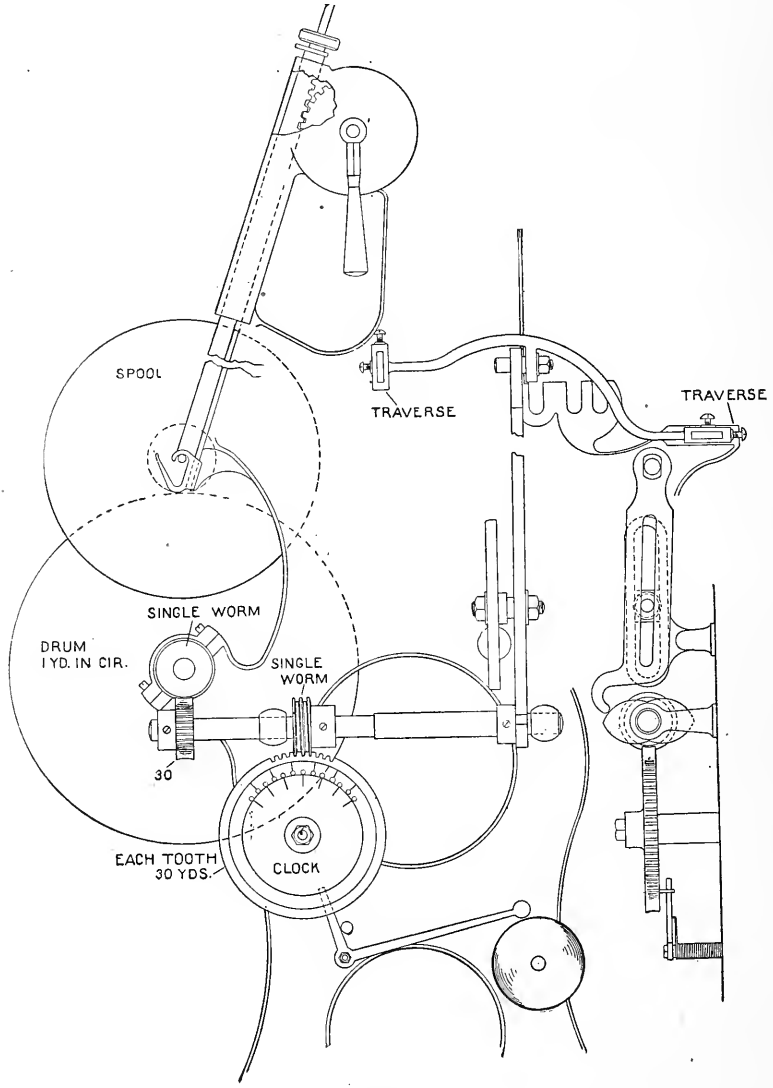


Fig. 41.

stage of preparation by the following defects: more tension on one spool than on another, loose threads, or, in short warps, insufficient

length on one or more spools. This latter defect is serious, necessitating the tying in of a short length to finish the warp and thereby making 40 or more knots to the warp, and all in one place.

The drum of the spooler is generally one yard in circumference (Figs. 41 and 42). At the end of the drum shaft a single worm is fixed ; this imparts motion to a 30-tooth gear. On the same shaft as this gear is a single worm, which drives the clock or indicator ;

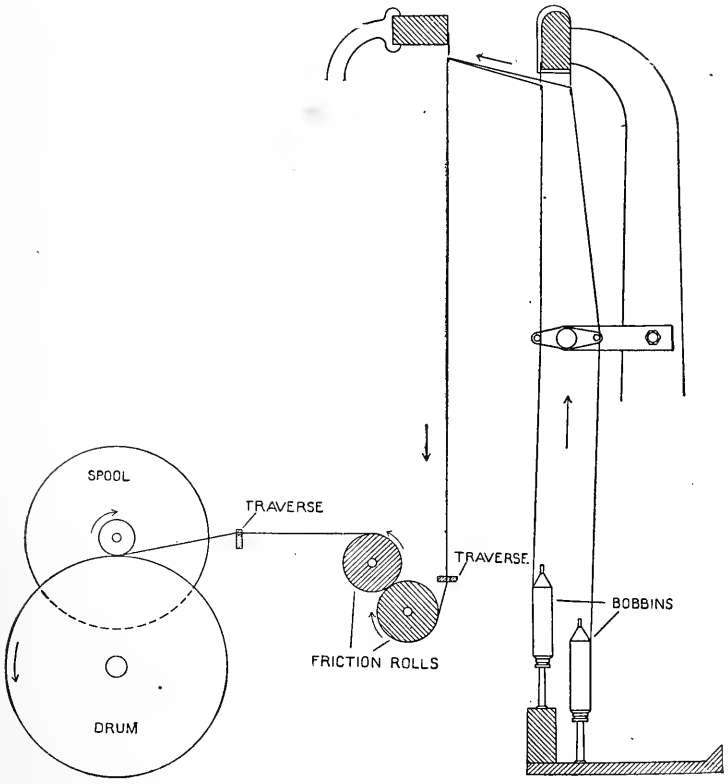


Fig. 42.

1 revolution of the drum = 1 tooth on the 30 gear; 1 revolution of the 30 gear = 1 tooth of the indicator, or 30 yards. It is better to run a trifle longer length on the spool than the yards shown on the indicator, owing to the possibility of the spool slipping when starting up.

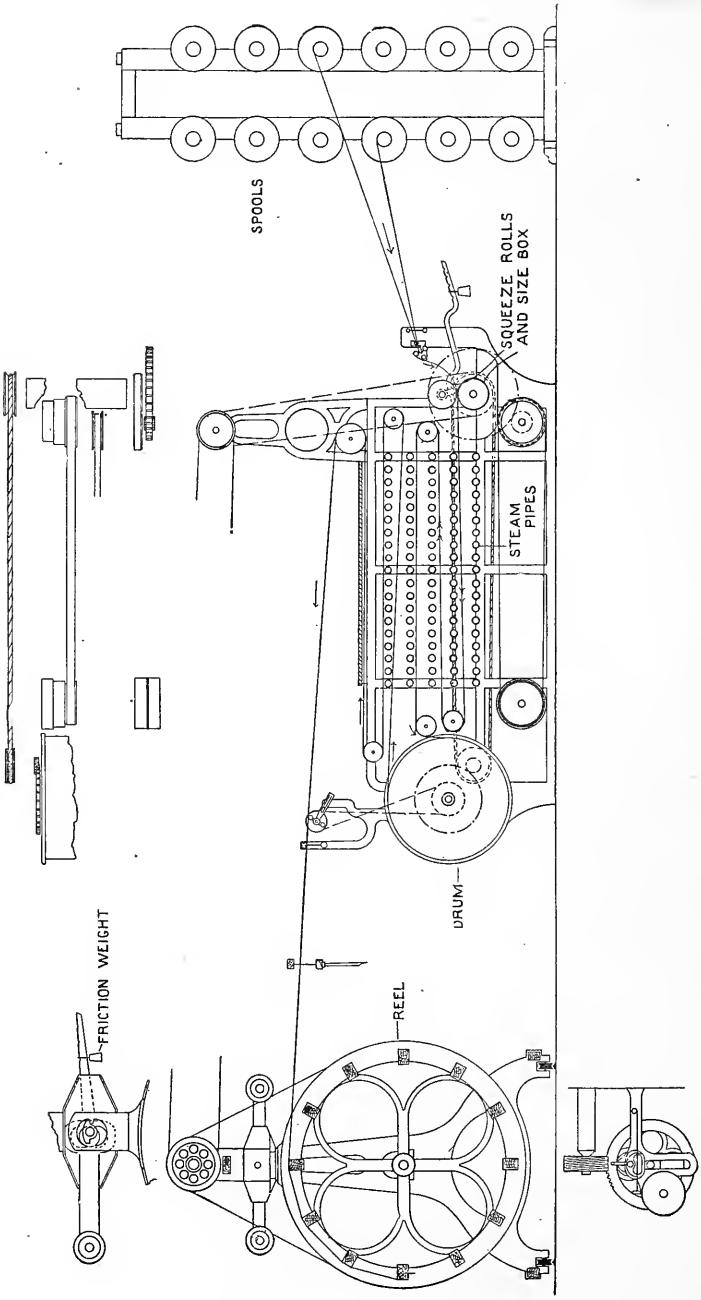
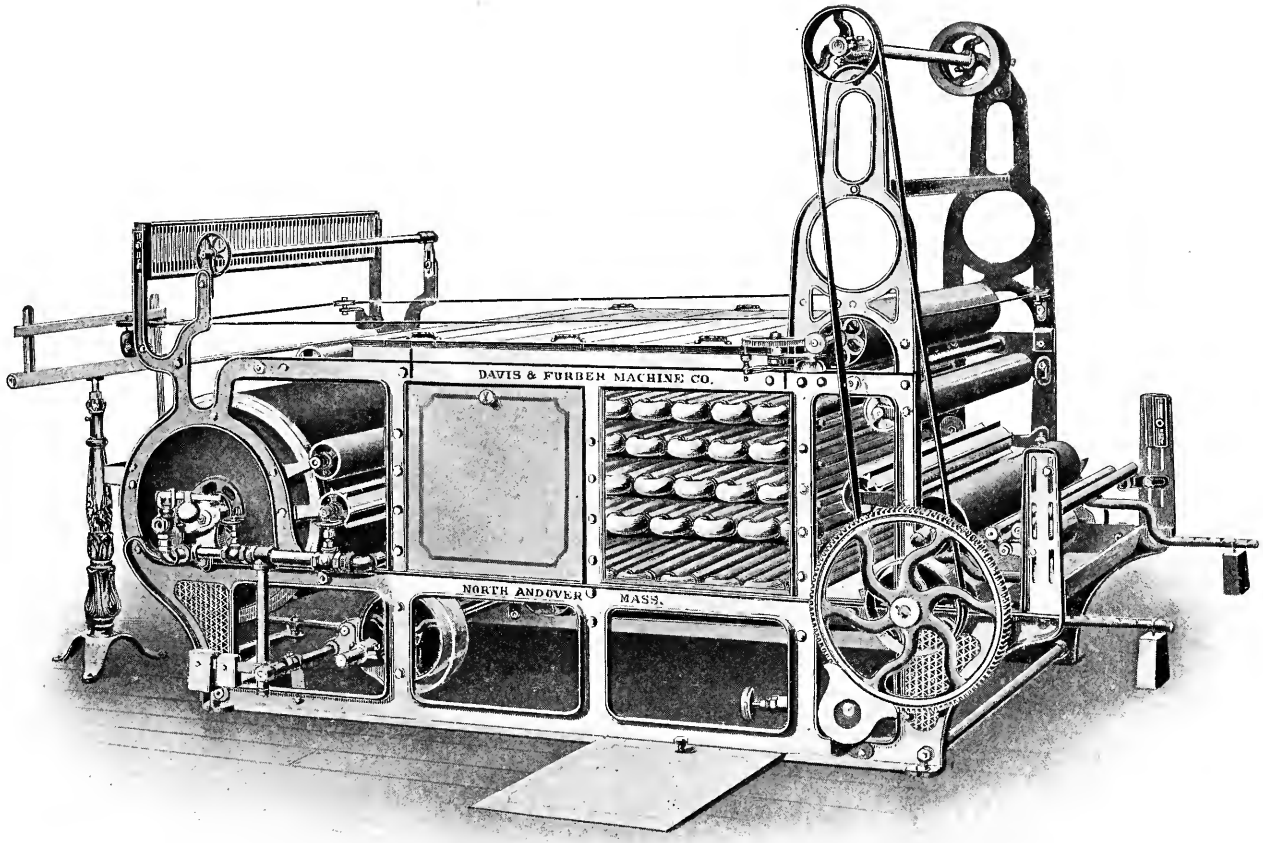

SPOOLS
SQUEEZE ROLLS AND SIZE BOX
STEAM PIPES
DRUM
REEL
FRICTION WEIGHT

Fig. 43.



STEAM DRESSER FOR MAKING WOOLEN AND WORSTED WARPS

Davis & Furber Machine Co.

Creel. The spools are placed in the creel or support behind the spooler. The creel holds 40 or 50 spools, according to the width of the spooler drum.

Steam Dresser. The purpose of the steam dresser is to immerse the yarn in a sizing compound and dry it before it reaches the reel (Fig. 43). The size gives greater strength to the warp threads and helps to lay the fibers, thereby making a smooth yarn. One of the greatest difficulties to contend with during the weaving process is the clinging together of the yarn. If this is not prevented, the long fibers are gradually worked loose by the reed, and the loose portions adhere to the ends in the form of balls or lumps, which cause the yarn to break frequently. Woolen yarns are almost always sized, but worsted yarns need only be sized when they are heavily sleyed; that is, when they have a large number of ends and picks, or when single (not two-ply) worsted warps are being used.

Sizing Compounds. For woolen yarns, 10 pounds starch, 14 pounds glue, 50 gallons of water and a little tallow.

Another compound is made up of 25 pounds of glue, 100 gallons of water and 2 pounds of tallow. In some instances Irish moss is used with a light solution of glue and tallow.

For worsted yarns, 50 gallons of water, 15 pounds starch, weak solution of Irish moss, 1 pound tallow. Another is composed of 60 gallons of water, 20 pounds of starch, 4 pounds dextrin, 2 pounds tallow.

If the creel holds 12 spools, 40 ends on each spool, or 480 ends in all, it is not necessary to have 480 ends in use; moreover, that number will not always divide equally in the number required to make the warp. Each section must be the same as another, if they are expected to join together to make one warp. For example, suppose there is one pattern and a half in one section; when the next section is laid on the reel the full pattern commences next to the half pattern in the last section, which would cause a break in the warp. If, however, equal patterns compose each section, they would join together without a break.

Occasionally when a very large pattern is to be made, for instance, a dress-goods pattern of 600 ends, one-half of the pattern could be made and placed on the reel in alternate sections, leaving

one empty section between for the next half of the pattern. With this method care must be taken when the pattern is tied in, or it will not match. Great care must also be exercised with regard to the friction. Instances are frequent where one section has had a trifle less friction than another, or by some fault has been allowed to run loose on the reel; the result has been uneven and baggy cloth.

It is not uncommon to add one or more spools to the capacity of the creel, these being placed in special stands. The demands of the pattern and the skill of the dresser determine the additions.

Formation of the Pattern. A warp of 1,944 ends, 30 yards in length, is required of the following pattern: 4 black, 2 dark blue, 1 slate, 2 blue; 9 ends in a pattern, 24 black ends on each side to be added for listing.

The first thing to consider is the capacity of the creel, because on a woolen dresser a warp of 1,944 ends cannot be made in one section; however, to overcome this, several sections can be made, which added together make one warp. In making this pattern on a creel of the above capacity, proceed as follows:

There are 1,944 ends, 9 ends to a pattern. $1,944 \div 9 = 216$ patterns. $216 \div 9 = 24$. There will be 9 sections with 24 patterns in a section, and, therefore, 216 ends in a section.

The total pattern is thus divided by a number that would give a practical working quantity.

The reason for not having 432 ends in a section (as the capacity of the creel is 480) is that 9 sections give an equal number of patterns in each section, whereas if we had 48 patterns in a section, or 432 ends, there would be only $4\frac{1}{2}$ sections, which would mean the waste of a large quantity of yarn. If a full pattern is taken from the spools, and afterward half a pattern is taken from the same spools, the other threads must be discarded, which is not practical in fancy patterns. Therefore this warp on this size creel and spools should have 9 sections with 24 patterns in each section. Multiply the number of ends of each color by the patterns in a section to get the total number of ends of each color.

4 Black	$\times 24 = 96$	2 spools of 40 ends; 16 over
2 Dark Blue	$\times 24 = 48$	2 spools of 40 ends; 16 over
1 Slate	$\times 24 = 24$	1 spool of 24 ends
2 Dark Blue	$\times 24 = 48$	5 spools

Place the ends that are left from the full spool; namely, 16 black and 16 dark blue, on one spool; 1 black, 1 blue. This gives 6 spools. It is best to run the selvedge from a separate spool. As the warp is to be 30 yards in length, and there are 9 sections from the same spools, run 9 times 30 yards from each spool, and also allow several yards for waste at the end of each section for tying the pattern, drawing in the warp, and for any possibility of loss through the spool slipping while the yarn is being spooled. Twelve yards, or a little over one yard for each section, is sufficient. This gives 282 yards on each spool. An indicator is placed on the spooler to show the number of yards run through the machine.

The spools are then placed in the creel of the dresser in the following order: the two black spools at the bottom, the spaced spool next, then two blue, and the slate at the top.

Picking the Pattern. There are three ways of doing this. *First*, the more common is to have all the ends that are in the reed at the bottom; then count off the ends according to the pattern. The black spools are at the bottom, blue next, and slate next. Take up the number for the slate first. Commence at the right-hand side of the reed and count 2 ends, let them remain down, then lift 1 end, which will be for the slate, and place it over the top of the reed, count 2 for blue, 4 black, then begin with the pattern again; 2 blue, and these together will make 8 ends; lift 1 over the reed, count 8, lift 1 over the reed, and so on until the number for the slate are picked out and laid over the reed. Tie these together, and let them remain over the reed. Count the ends for the blue, 2 and 2, making 4; place them over the reed, leave 4 down for the black, pass 4 over the reed, leave 4 down for black, and so on to the end. Tie these together as before and lay them over the reed. All that remain down are for the black, but it is well to count them in order to be sure of this.

When there are 3 or 4 spools of one color, the ends are counted off in forties and bunched together, after completing the above process. For example, if there are 4 spools of black, take the first end of each of the 4 that are counted in the reed for black, and tie them together; then the second in each 4, the third and the fourth. Separate the other colors in the same manner, afterwards

placing all the yarn over the reed. Then pulling down the first bunch of forties for the black, tie them to the bottom spool, then the second bunch to the second spool, and so on. But with the pattern by the first method there is no necessity to separate the ends that have been counted in the reed; take all the black threads and tie to them the ones on the spools. Commence at the bottom for the first end, and 1 from the second spool for the second end, and the black end on the spaced spool can be tied to the third in the reed. Then start on the bottom spool again, keeping them as straight as possible, passing from the bottom to the top spool however many there are. After the black ends are tied in, follow with the blue, then the slate. The ends must not be crossed any more than possible, because they will become tangled in the reed and will be broken frequently. This applies to all warps that are placed in the dresser.

It sometimes happens that the spaced spool has 2 or 3 threads of one color side by side, and 1 of another color. In order that the single thread may come in a straight line in the reed, take no notice of the single thread on the spaced spool when piecing the first bunch of ends of that color starting at the bottom spool of the same color until sufficient ends have been tied in the reed for the single thread to run straight, or as nearly straight as possible. A little thought concerning this will save endless trouble.

The Second Method requires great care and must not be interrupted until all the warp is tied in. It is not often attempted except in simple patterns, and then only by competent operatives. The ends are not counted in the reed, a bunch of them being taken and the ends on the spools tied to them, as the pattern calls for them; the one who ties them constantly glancing at the pattern paper.

The Third Method. The following is the writer's method, and one which he considers to be the safest, best and most rapid. Count the threads in the reed, and cast over the top of the reed the last end of each color; when this end is reached the operative knows that it is the last of the color being tied in. It is very convenient when there are several of one color together. After casting over the last thread in each number, take a bunch of those

that are down, and tie them to the threads on the spools according to the pattern. Glance at the pattern occasionally while so doing.

This method has a decided advantage, inasmuch as it is not necessary to lean over the threads after a few have been pieced, as must be done in the first method when one spool is tied in at a time; consequently there is less risk of twisting the threads, which often causes a number of them to break as they are drawn through the reed. The operative recedes from the threads as they are pieced, and after awhile he will become expert enough to piece the threads so that even one slack end will be an exception. It also means that about an hour has been saved in the picking out of the pattern, and the operative is able to draw the ends straight through the reed without snarling, as frequently happens if they become loose or are rubbed. Some dresser tenders twist the threads together, which is a very good method after proficiency has been attained.

After the warp is tied in, it passes between flannel-covered iron squeeze rolls. The lower roll is partly immersed in the size, which is placed in the size vat. The vats are jacketed; that is, they have a steam chamber underneath them. Perforated pipe cannot be used with any degree of success when the size contains glue. From the vat the yarn passes around the steam pipes and the copper cylinder, and over the measuring roll. Iron rods and tin rollers are used to keep the yarn off the pipes. The tin rolls nearest the size vat are in skeleton form, so that the yarn will not adhere to the rolls as it passes around them.

Leese Reed. From the measuring roll the yarn passes through the leese reed. This is a blocked reed, one dent being empty and the next blocked; that is, one-third is closed at the top and a third at the bottom, leaving the remaining third open in the middle. Each alternate dent is treated in this manner. One end passes through the open dent, and one through the blocked dent. Both the pattern reed and the leese reed should be of the same count, say 10 dents to the inch.

Condenser Reed. The yarn then passes through the condenser reed, which condenses it to the width of the section on the reel. The total number of ends in a section must be equally divided in the dents of the condenser reed. If there are several

more in one dent than another, they tend to crowd on the reel, with the result that they are stretched too much, or they will break constantly. Either of these faults make poor cloth.

To determine the number of ends to be placed in the condenser reed and the width of each section, proceed as follows: There are 9 sections. If the reed has 10 dents to the inch, and the warp is to be $31\frac{1}{2}$ inches in width, $31\frac{1}{2} \div 9 = 3\frac{1}{2}$ inches in each section. There are 216 ends in a section. Ten dents multiplied by $3\frac{1}{2} = 35$ dents. $216 \div 35 = 6$ and 6 ends extra; therefore, place 6 ends in each dent of the condenser, and distribute the extra 6 ends as equally as possible.

In making a warp with 238 ends in a section, and the sections $4\frac{1}{5}$ inches wide, to find the number of ends in a dent in the condenser,

$$238 \div 42 = 5 \text{ and } 28 \text{ over.}$$

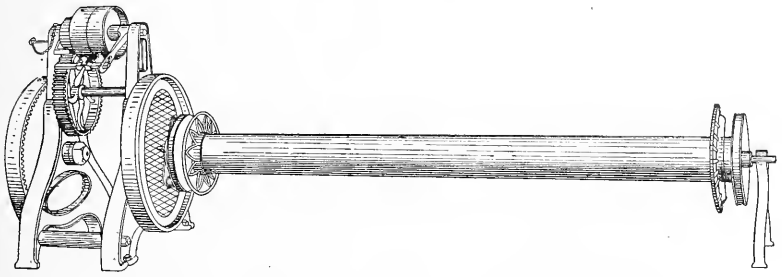
Two-thirds of 42 is 28, therefore 6 are placed in each 2 dents out of every 3, and 5 in the third; they will be distributed equally. $6 + 6 + 5 = 17$. $42 \div 3 = 14$; $17 \times 14 = 238$.

Taking the Leese. The yarn is first bunched and fastened to the pin on the reel. By the aid of two rods the leese is taken, but the manner in which this is done must be remembered, that is, whether the yarn is first pressed down or lifted up, or two threads will come together in the same leese at the end of the section. With one rod press down the yarn near the reed on the side nearest the reel. This causes the ends that are in the open dents to go below those in the blocked dents; they will form an opening, each alternate thread being at the bottom and the other threads at the top. Pass a rod through this opening, and open out the ends until there is a clear space beyond the condenser reed; now pass a cord through this space, take out the rods and lift up the yarn, so that the threads which were at the bottom will be at the top. Pass a rod through this opening, and open out the yarn as before, then pass a cord through this, and the result is a single leese. This must be followed out at the beginning of each section.

After the leese is taken, set the measuring clock. One tooth gives 18 inches, 2 teeth 1 yard, so that 60 teeth indicate 30 yards. To the first and last sections the selvedge threads are added. Start up the reel, taking care that the yarn passing

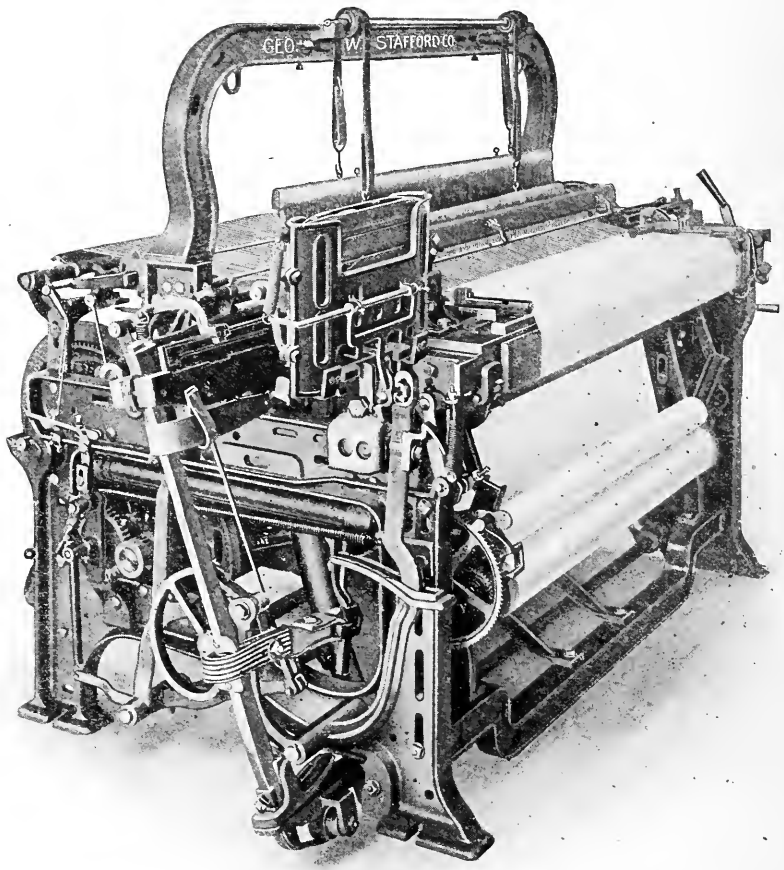
through the condenser goes straight inside the section pins. When the length is run on the reel, cut off and tie the ends into a knot for the next section. Fasten the yarn to the pin on the reel, draw the reel on the track until the next section is opposite the condenser, and take the leese as before. Follow this order until finished, setting the clock at every commencement.

Reel. When the width of the section has been determined, pins are placed in the bars of the reel to correspond with that distance, so that the yarn will be laid straight on the reel, without one section overlapping another. When all the sections are placed on the reel, they constitute a warp of the number of ends required, 1,944, with the addition of the selvedges.



Beaming. Before beaming, loosen the belts around the reel, and add the friction, then tie the yarn to the leader. This is generally a piece of burlap attached to the beam. If a small quantity is tied at once, better warp is made, as the knot will be smaller. The amount of friction required must be determined by circumstances. Do not make a soft beam, and do not add too much friction, or it will strain the yarn; 7 or 8 pounds of steam are sufficient for drying purposes, and it is well to shut off the steam if the dresser is to be stopped for any length of time, or the yarn will be burned. It is also well to have separate connections for the size vat from the steam pipes, so that they can be run independently.

Press Roll. This is a recent invention for making better beamed warp; it also allows more length of yarn to be placed on the beam. It is of great value, because the beam is harder pressed, thereby preventing the layers from sticking to each other, with less possible chance of uneven cloth.



IDEAL AUTOMATIC LOOM FOR PLAIN GOODS

The Geo. W. Stafford Co.

WEAVING.

PART I.

TWISTING AND DRAWING IN WARPS.

In some mills, so little attention is given to this department that it is no uncommon thing to see a warp cut out of a loom on account of bad harnesses. This means extra cost credited to the weaving department, for the man who generally has charge of this branch is in turn responsible to the overseer of weaving. Lack of inspection of harnesses when out of the loom, or in the loom when a warp has been woven out, results in considerable unnecessary expense. Harnesses are frequently cast aside, which by means of a little repairing could be made almost as good as new.

A little tallow brushed on the wire heddles and heddle rods will make the heddles last two or three years longer than if they were rubbed with oil, and most certainly longer than if no lubricant were applied. Tallow does not run as much as oil; when placing it on the harnesses, a brush should be used that will apply it to the heddles uniformly. When applied unevenly, the loose fibres which fall from the yarn during the weaving process cling to the lumps of tallow, and the ends of the heddles stick together. This often causes the yarn to break, especially after a thread has been drawn in, owing to the heddles not returning to place.

Another advantage that a good tallow has over oil is that there is less staining of the yarn caused by the oil running into the eyes of the heddles. A stain woven into the cloth is extremely hard to wash out, and sometimes does not yield even to bleaching, but leaves a yellow spot. This of course means second quality cloth. By giving the harnesses the proper amount of attention, the fixer can start up a warp in less time, and also save the weaver the piecing of many smashes. When oil is applied to the heddles in the weave room, twice as much is used as is necessary, and one-half of it is generally on the yarn, with stained cloth as the result. It is a well-known

fact that the lack of care in the harness room is often the cause of a few pieces of cloth costing one-quarter more than they should cost, besides causing endless trouble in the weave room and cloth warehouse.

If the small nut which is generally placed on the end of the heddle rod outside the harness frame is left off, a smash is often the result; for the rod slips through the frame and the heddles drop into the yarn. Some heddle rods have two ridges in the center; if the hook which supports the rod is not between these ridges, the rod slips out and a heddle smash follows.

Cotton harnesses require just as much care as wire heddles, possibly more; they ought to be handled very carefully. Harness eyes are often cracked by careless handling, so that when the warp is placed in the loom, the ends are frequently broken out by catching in the injured eye. Cotton harnesses are always varnished, for they give better results when they are very smooth.

Smooth harnesses are to be desired, even though they may be stiffer; if the harness-maker does not brush them thoroughly, especially after they have been varnished, or if by an oversight they are brushed in the wrong direction, small lumps are left on the harnesses, and these chafe the yarn.

If the harnesses are very stiff they are likely to crack, and sometimes the cracks are so small that when the harnesses are in the loom, the cause of the yarn's breaking out is not easily seen. It is far better to spend a half-hour in thoroughly examining the harnesses or heddles before the warp is drawn in, than to have the warp go to the weave room with the possibility of cutting out because of their being imperfect.

The diagram at Fig. 44 shows the harnesses and a method of actuating the same when used in hand looms. Fig. 45 is a sectional view of modern harnesses and heddles.

The counts of cotton harnesses, or number of eyes on a shaft, are designated as so many beers in a certain number of inches; there are always 20 eyes in a beer. A beer is distinguished by a cord that passes on the outside of each 20 harness threads, and at the bottom of the shaft.

Example: Harnesses are required for a plain cloth 30 inches wide and 72 ends per inch in the reed. Two shades are necessary

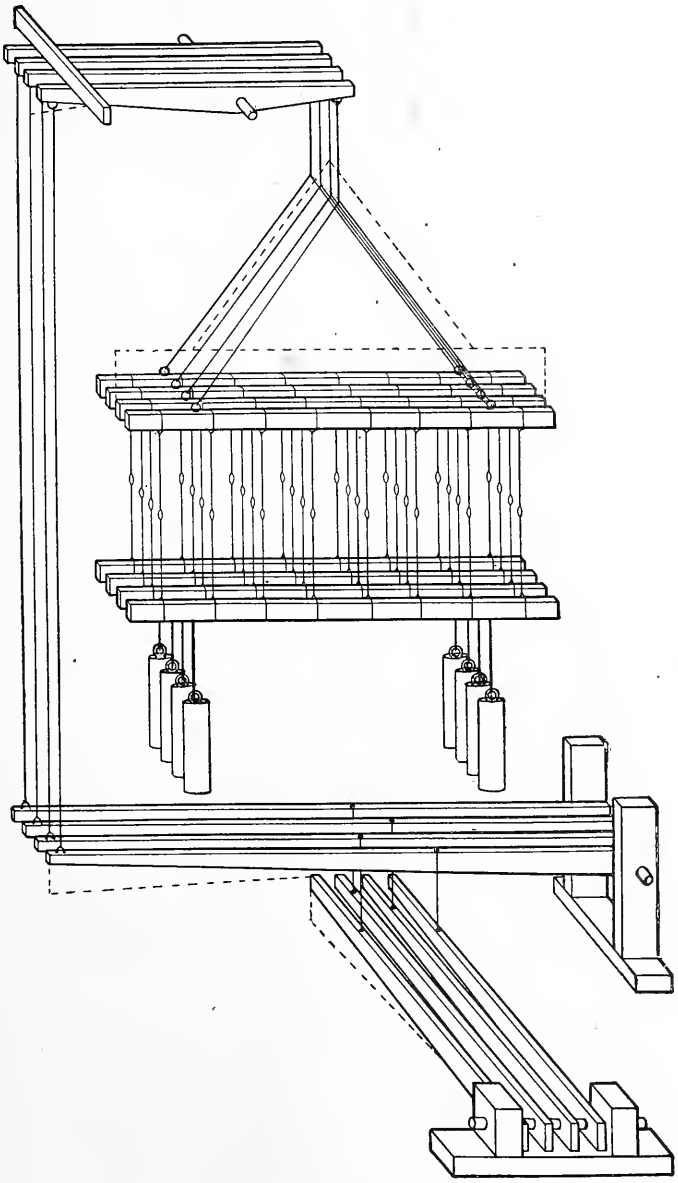


Fig. 44. Handloom Mechanism.

in making plain cloth, and we should use a 36 reed, two ends in a dent. Each shade or harness shaft would then have on it 36 harness eyes in one inch. $36 \times 30 = 1{,}080$ harness eyes. $1{,}080 \div 20 = 54$ beers. It is customary to add extra eyes for the selvedge threads, so that the harnesses would be ordered as follows: One set of harnesses, two shades, with $55\frac{1}{5}$ beers in $30\frac{2}{3}$ inches, or 1,104 eyes on each shaft; the depth of harnesses to be 10 inches.

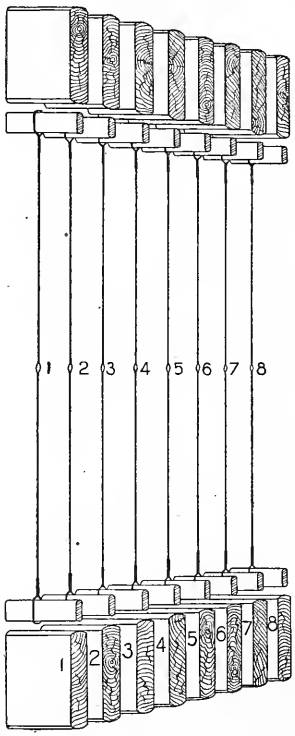


Fig. 45. Sectional view of Harnesses.

When calculating for cloth that requires 3, 4, 5, or more shades, the number of ends in the warp apart from the selvedges are divided by the number of shades, the result is again divided by the number of ends in a beer. When calculating for spaced harnesses, such as are used for striped patterns, the width of the stripes determine the number of eyes on each shaft.

Example: A satin and plain striped cloth, 28 inches in the reed, 40^s reed; plain stripe to have 60 ends in $\frac{3}{4}$ of an inch; satin stripe to have 50 ends in $\frac{1}{4}$ inch: 5-harness satin weave. It is best to have a striped cloth finished with both edges alike; that is, if the stripe near the selvedge on one side is plain, the stripe near the other selvedge ought to be plain also. Consequently the above pattern, to have equal edges, would start on one side with $\frac{3}{8}$ of an inch of plain, then $\frac{1}{4}$-inch satin. The full pattern of $\frac{3}{4}$-inch plain and $\frac{1}{4}$-inch satin would then be repeated 27 times, and there would be $\frac{3}{8}$ of an inch of plain left. This would make both edges equal. The plain shades would be ordered as follows: Two shades, knit 15 eyes on $\frac{3}{8}$ of an inch, drop $\frac{1}{4}$ of an inch; then commence with full pattern. Knit 30 eyes on $\frac{3}{4}$ of an inch, drop $\frac{1}{4}$ inch, and repeat the full pattern 27 times. Finish with 15 eyes on $\frac{3}{8}$ of an inch. The satin would be 5 shades; miss $\frac{3}{8}$ inch, then commence with full pattern, knit 10

eyes on $\frac{1}{4}$ of an inch, drop $\frac{3}{4}$ of an inch. Repeat the pattern, or the knit spaces 28 times. Sometimes the spaces are marked off on the harness shaft, as a guide to the knitter. The number of yards on all of the shades would be: plain, 1,680; satin, 1,400; total, 3,080.

Casting out is often resorted to in mills where cotton harnesses are used extensively. Casting out means not using a certain number of eyes, so that a set of harness shades can be used for a coarser reed than they were intended for when first knit. This often saves the purchasing of a new set of harnesses, but they are not as convenient for the weaver when threads break out, necessitating greater care.

Example: A set of harnesses has 36 eyes to the inch, and is to be used with a 30^s reed, so that there are 6 eyes per inch more than are required. It is best in such a case to cast out these eyes every half-inch, because casting out 6 eyes together would cause too wide a space. When the harnesses are placed on the frame, 30 ends are drawn in, 15 on each shade, then 6 eyes are cast out, 3 on each shade; this order is followed out to the end of the warp.

Cotton harnesses give the better results; they are easier on the yarn, because they yield somewhat to its tension; and also because there is a smaller loss of elasticity from the yarn, than there is by the use of wire heddles. Cotton harnesses are more costly than wire heddles; when used for fancy stripes they can be used only for one particular pattern or one that is similar, whereas wire heddles can be used on any number of patterns.

Twisting and Drawing In. Twisting in a warp means connecting the ends of a new warp to the ends remaining from a former warp that has either been woven out or cut out. The twists are drawn through the eyes of the harnesses or heddles, also through the reed; the warp is then ready for weaving. The lower sketch in Fig. 46 shows the actual position of the threads when being "twisted." The upper sketch shows the position which they assume when the opperation has been completed.

Drawing in the warp means drawing one or more ends through one eye of the harness or heddle at one time, and continuing this until all of the warp threads have been drawn through their respective eyes; the ends are then drawn through the reed and the warp is ready to be placed in the loom.

The question as to whether it is cheaper to draw in warps or twist them in, is one that can only be decided by the class of fabrics woven and the circumstances surrounding the mill. Some overseers seem to be prejudiced against either one system or the other. Drawing in the warp is the better in mills where there is constant changing of patterns, and is in fact quite necessary; one or two twisters are, however, generally employed, besides those who draw in the warps.

Twisters are more generally employed in mills where patterns are repeated for two or more warps, and especially where striped fabrics are woven; also in mills where two or more warps are required to produce certain fabrics. When several warps are used, one of them is likely to be woven up before the others; then of course a new warp is twisted in. This saves the cost of taking the pattern out of the loom.

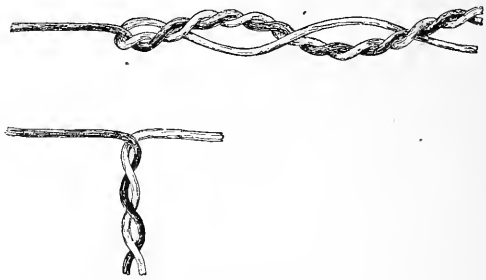


Fig. 47. "Twisted" Warp Yarns.

In mills where nothing but plain cloth is woven, it is generally a question of competent or incompetent employees, as to whether twisting is more profitable than drawing in.

So far as is possible a warp should be drawn in the reed equally, that is, if any part of the reed is left vacant, the spare dents should be equal in number on each side of the warp. This helps to make a better selvedge than if all the spare dents were on one side, because the wider the space from the selvedge to the box, the more slack filling there is to be drawn through the shed, and to get this through so as to make a good selvedge, more power must be applied to the pick from that side. The pattern determines the number of wire heddles that are to be placed on each harness frame.

Example: A warp of 2,490 ends has been made, and the cloth is to be a shaloon twill (cotton) or cassimere (woolen), in other words a $\frac{2}{2}$ twill. This will be a solid cloth, no stripes in it. Such a twill requires but 4 harnesses to weave it, but better results

would be obtained by using 8 harnesses, because there would then be less crowding of the heddles, which is an advantage. When a solid cloth is to be made, the total number of ends are divided by the number of harnesses, and the result gives the number of heddles to be placed on each shaft. It is customary to allow a number of extra heddles for the selvedge, and the cloth appears better if the selvedges are drawn in to form a different weave from that of the body of the cloth. $2{,}490 \div 8 = 311$ with 2 over. If 315 heddles are placed on each shaft, these will allow for both the warp and selvedge threads. When a striped fabric, the easiest method is to examine the drawing-in draft which is generally marked for one pattern. Multiply the threads shown on the draft for each harness, by the number of patterns, and this will give the number required.

Example: — For drawing draft (see Fig. 47.)

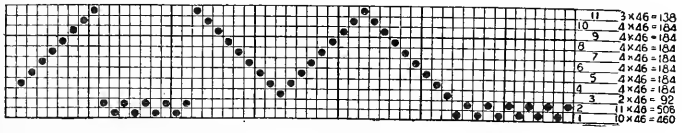


Fig. 47. Drawing Draft for 11 Harnesses.

54 ends in a pattern. 46 patterns. $54 \times 46 = 2{,}484$ ends. Heddles required on each shaft.

Harness No. 11 — 138 heddles,
" 10 — 184 "
" 9 — 184 "
" 8 — 184 "
" 7 — 184 "
" 6 — 184 "
" 5 — 184 "
" 4 — 184 "
" 3 — 92 "
" 2 — 506 "
" 1 — 460 " } add a few extra heddles for selvedge.

Better results are obtained by having 4 harnesses instead of 2 for the plain stripe. If these are added, it is necessary only to divide the number on each shaft by two.

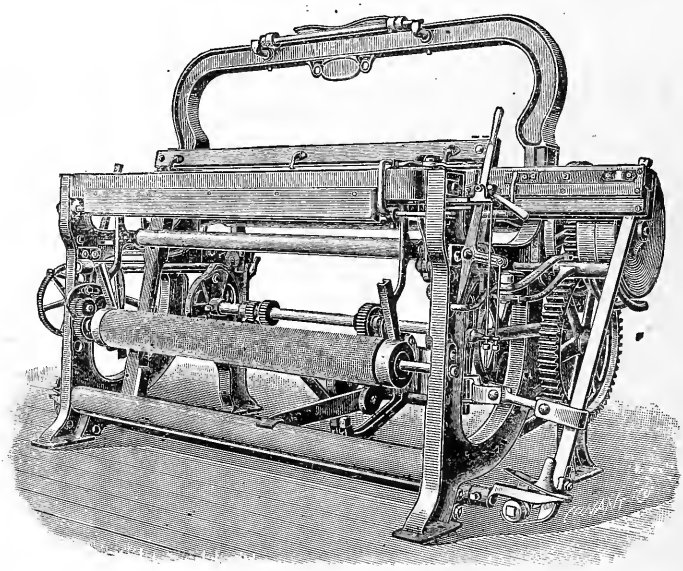
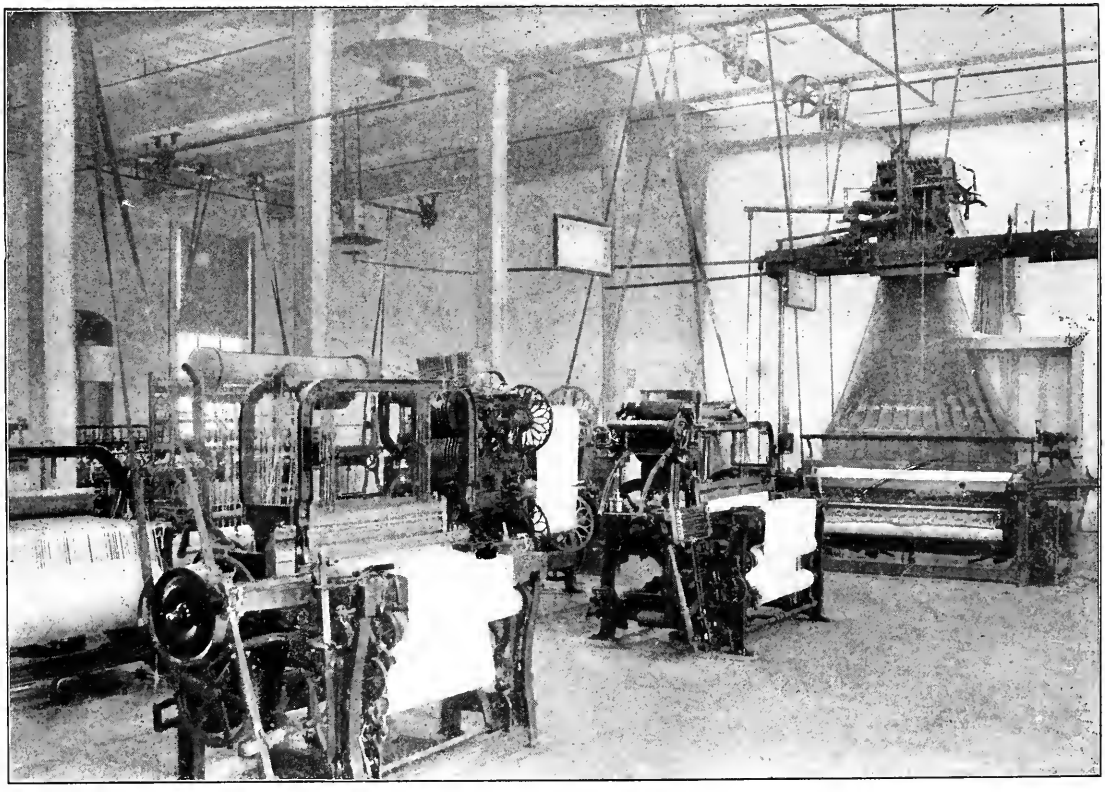


Fig. 48. Modern Interchangeable Plain Loom.

THE PLAIN POWER LOOM.

There are many kinds of plain power looms on the market, but at the present time the demand for such a diversity of cloth necessitates so much changing in mills that a loom should be bought in which is taken into consideration, this diversity of fabrics. There are looms which will weave the best of plain cloths, but which are not adapted even for sateens or twills, without reckoning fancy cloths woven by means of a dobby, unless great expense attends the changing over.

In buying looms a great deal more depends upon their build with regard to production than is generally taken into consideration, for a loom that will run for several months and then remain almost continually out of order is of little value. There are a number of looms of this kind on the market to-day. At first they appear to be very light-running looms, their cost being a trifle less than the somewhat heavier ones. After these light machines have been running about twelve months new castings are required frequently, and as is generally the case, a badly constructed loom has a number of large cast-



VIEW IN WEAVE ROOM OF CLEMSON COLLEGE, SHOWING FANCY LOOMS

ings in its makeup ; therefore, when a small portion wears out a large portion has to be replaced, necessitating repairs costing two or three times more than those of a properly constructed loom. It does not necessarily mean weakness when several parts are bolted together instead of being cast in one large piece ; for there are several motions that could with profit be made in small sections, instead of in one solid piece. If small sections are fitted and bolted together properly, they would add to the better running of the loom, and it would cost less to replace a worn part. For example : it is much better to have the bracket or lugs, separate from the crank-pin than to have the pin cast with the bracket ; for by means of the former construction the pin can be readily replaced when worn, while with the latter way the bracket must be replaced also.

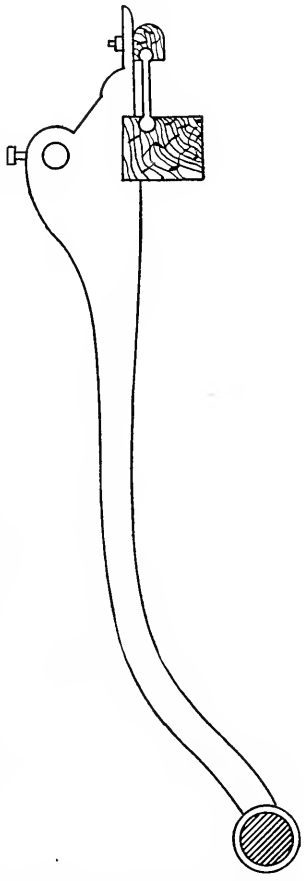
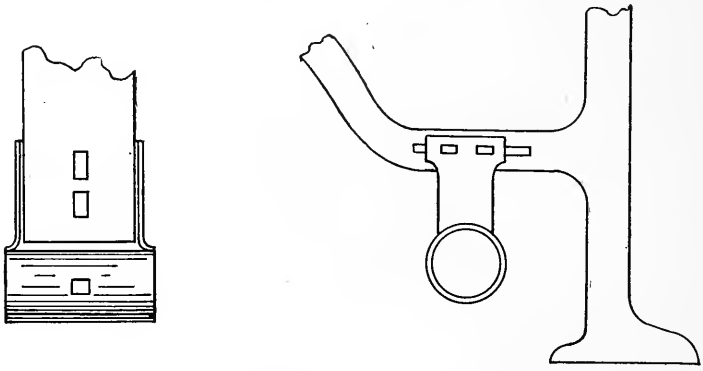


Fig. 49. Lay Sword with Rocker Shaft Connections.

In some looms the lower portion of the lay sword (as in Fig. 49) is large enough to have a hole drilled in it, through which the rocker shaft passes. This necessitates useless expense, for when repairing, it often requires the labor of two persons to remove the rocker shaft, one to twist and turn the shaft to get it out, and the other to keep the further lay sword perpendicular, for if it moves in the least it binds the shaft. This part constructed in the following manner is repaired in much less time : (see Figs. 50 and 51). If the lower portion of the lay sword is bolted to a bracket, which is set-screwed to the rocker shaft, it is a comparatively easy matter to loosen the bracket from the lay sword and to then loosen the boxes of the shaft and draw it out. The shaft cannot bind, so there is no need of using an extra man's time.

The pick cams can be made in two parts, aside from the point

or nose. A circular plate is compounded with the boss, and through which the shaft passes, this portion being fixed to the shaft. Attached to this fixed portion should be the outer portion of the cam, which comes in contact with the picking cone. This being separate from the fixed plate can be moved backward or forward, as the case demands, to give an early or late pick. It is the constant loosening and tightening of the set screws that fasten the cam to the shaft which cause trouble, although if the set screws are cupped and chilled, they bite the shaft and there is less difficulty than when ordinary set screws are used.



Figs. 50 and 51. Two part Lay Sword.

Fig. 52, another style of sectional pick cam, when cast in the right manner, is a fine cam, but costly when the draughtsman does not understand the work it has to perform. There are other matters of a similar nature that will be explained later.

These are essential points to be considered in connection with looms, and if not carefully considered will result in a loss of production and a consequent increase in cost of same. Any loom that is frequently out of repair means a loss caused by its standing, and also loss of attention that the other looms require; moreover, the cloth produced by such a loom is not up to requirements.

Some of the disadvantages attendant upon changing over a loom, from plain goods to a 3-harness twill, which is not fitted with an auxiliary shaft, are here set down. An ordinary plain loom cannot be changed to weave the twill until an auxiliary or sleeve shaft has

been fitted on, and before commencing this all the running parts of the loom must be loosened. A practical man knows what this means, and especially if he has ever been troubled with his picking motion. Even then most looms are not built with space enough to allow for the change, the depth of the loom from breast beam to whip roll being insufficient. If an attempt is made to weave sateens the movement of the lay is not sufficient, and the crank shaft must be changed for one with a larger crank; otherwise, in a sateen cloth of 120 picks per inch or more, a very small shuttle will have to be used or the side ends will be broken frequently. Then again a stronger pick is required to force the shuttle across the lay before the shed closes. These objectionable points are all prevented by buying looms that are built with the expectation of being changed over to weave any ordinary fancy cloth, even if the addition of a dobby head be necessary. (See Fig. 53.)

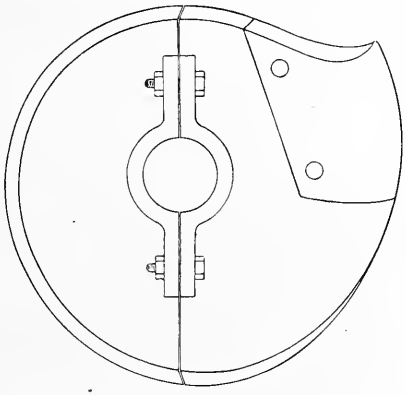


Fig. 52. Sectional Pick Cam.

SHEDDING MOTION.

The build of the shedding cams greatly influences the rest of the working parts of the loom. Too little attention is given to these essentials in consideration of the return which is expected from them. It is impossible to get good returns from an imperfect source; and it is well known that if the harnesses are working disproportionately, poor results will ensue. Unequal shedding is the cause of endless trouble both to fixer and weaver, and the cloth resulting therefrom is not fit for sale as firsts. The greater care should be taken, not only in the construction of the cam, but in the fitting of the cam to the requirements of the cloth to be woven. On some cloths very little dwell of the harnesses is necessary; simply have the shed well opened a sufficient length of time to allow the shuttle to pass wholly through. A very short dwell of the harness

is better for the yarn, as there is less actual strain upon it when the shed is opened gradually than when it is suddenly opened.

The term "dwell" means the effect of that portion of the cam which keeps the harness at rest for a certain part of one revolution of the crank shaft, and during a portion of which time the shuttle is passing through the shed.

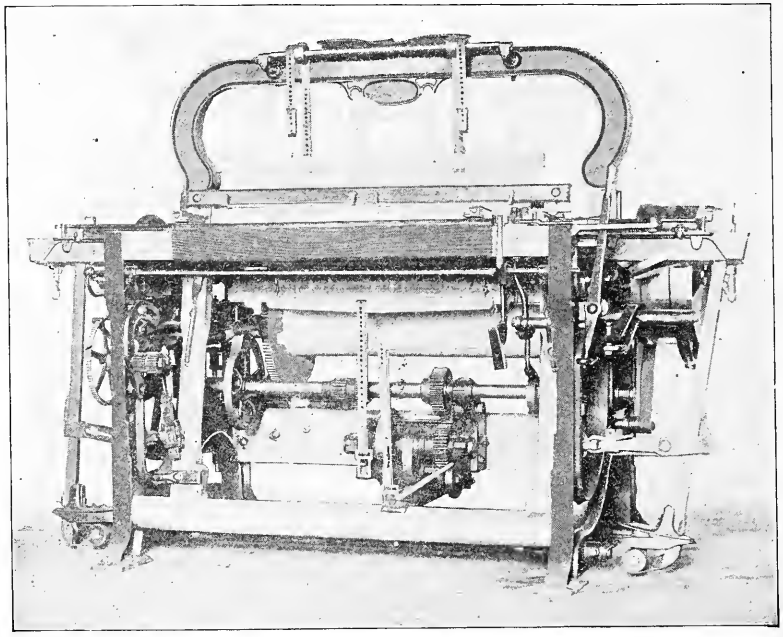


Fig. 53. Open Front of Loom Showing all Motions Connected.

Although the shedding motion is the first principal movement, it must be so constructed that it will conform to, and be on time with the second principal movement, picking. Hence the reason for a certain amount of the revolution of the crank shaft being spoken of as a dwell of the harness.

The shedding motion is the first of the three principal movements in weaving. The parts of the motion for the plain loom are shown in the diagram at Fig. 54, and are as follows:

A	Shedding Cams	D′	Top Harness Straps
B	Treadles	E	Harness Roller and Set Collars
B′	Treadle Pin	F	Lambs or Harness Jacks
C	Treadle Bowl	G	Back Harness
D	Bottom Harness Straps	H	Front Harness

The shedding cams are fixed in such a position on the cam shaft that they will, when in motion, operate the treadles. The sketch represents two cams used in making plain cloth; as one treadle is depressed by the extended portion of the cam, A, the other treadle is raised, and for the next pick the opposite takes place. That is, the harness that was first depressed is raised, and the one that was raised is depressed, the extended portion of the cam pressing it down. This action of the treadles is due to the manner in which they are connected, as shown in the sketch. The back harness strap is con-

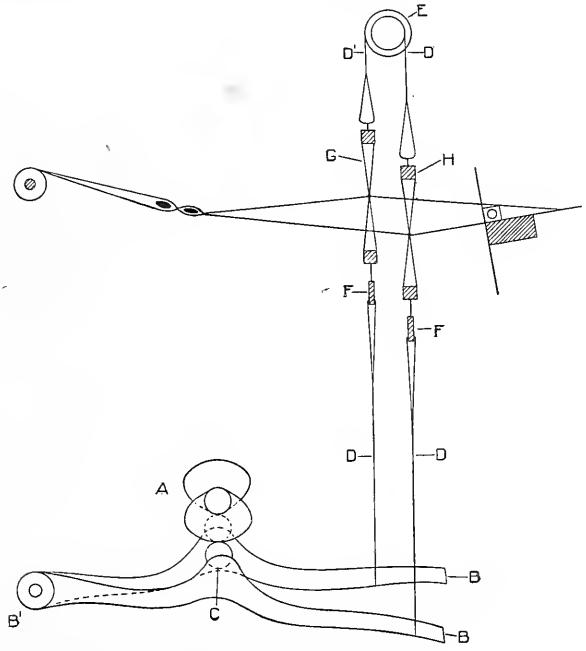


Fig. 54. Shedding Motion.

nected with the treadle that is raised, and at the top it is attached to the lamb, F. This lamb is connected with the bottom of the harness, G, by means of a hook; the top of the harness is connected by a similar hook to the top harness strap D.' This strap is fastened to the large set collar on the harness roller E. The front harness connections are the same as those of the back harness, with the exception that the lower strap is nearer the end of the treadle, and instead of the top strap passing round the roller from the back, it

goes over the front of the roller, and is fastened to the small set collar. Being arranged in this manner, as one treadle is depressed the strap that is connected with that treadle is unwound from the collar, while the strap attached to the harness that is connected with the raised treadle is wound on the collar. This order is carried out while the loom is in motion.

Cams Adapted to Different Kinds of Work. There are four kinds of cams: the eccentric or circular cam, $\frac{1}{3}$ dwell cam, $\frac{1}{2}$ dwell cam, $\frac{2}{3}$ dwell cam.

The $\frac{1}{3}$, $\frac{1}{2}$ and $\frac{2}{3}$ used with reference to these cams means that that portion of a revolution of the crank shaft is allowed in each case for the harness to dwell or to be practically stationary.

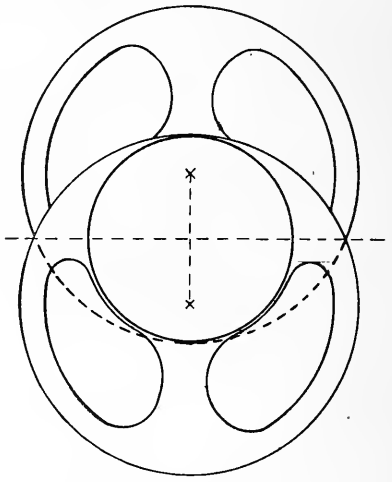
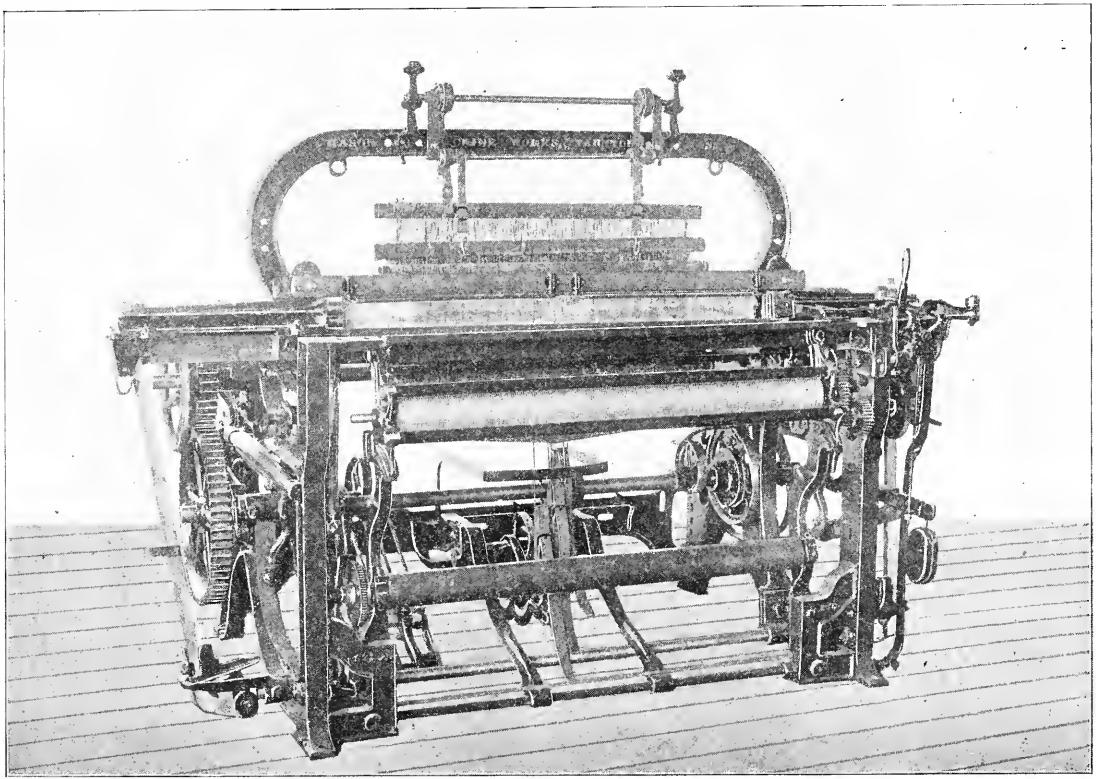


Fig. 55. Circular Cams.

Fig. 55 shows a cam that is not very extensively used, as it requires great skill on the part of the fixer to handle it in the loom, for all working parts must be timed to exactness. As will be noticed by the shape of the cam, there is no dwell or rest of the harnesses; they are constantly moving, but there is also the least possible strain on the yarn, for there is no quick movement to be made in order to make up for a rest at some part of the revolution. The tenderest and finest of yarns can be woven by such cams, but it is necessary, unless a very small shuttle is used, to have a little larger shed so that the shuttle will go through on time. This shows where the skill in fixing is required; the setting of the pick motion must be in perfect time with the shed, so that the shuttle will not rub unduly against the selvedge threads.

Fig. 56 shows a cam with a dwell of $\frac{1}{3}$ the revolution of the crank shaft. Under ordinary circumstances this is about the shortest dwell that can practically be used, and then only when the commonest grades of cloth are being woven and with poor yarns that it is used in the loom. If it is not in good time with the



SHEETING LOOM EQUIPPED WITH SPECIAL TAKE-UP

Mason Machine Co.

pick motion there will be poor selvedges, the threads breaking frequently; also more power is required to drive the shuttle across the lay, for on coarse cloths a large shuttle is necessary in order to hold a reasonable amount of filling.

A very practical cam one-half dwell, is shown at Fig. 57, and which is applicable to almost all cases. It gives ample time for the shuttle to go through the shed, the change of the harness is not as sudden as to unduly strain the yarn, the timing of the shed can

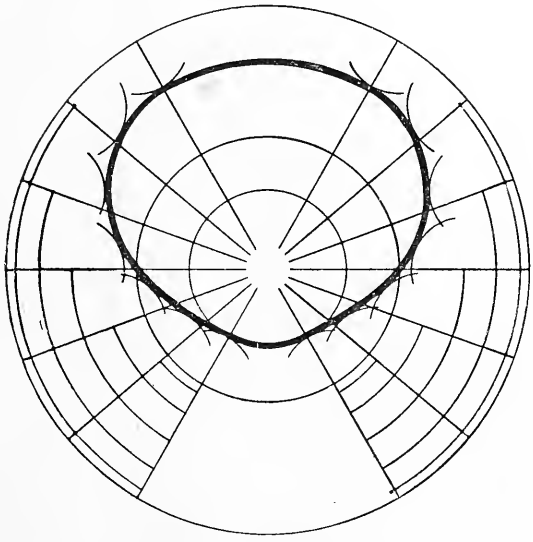


Fig. 56. Plain Cam, ⅓ Dwell.

also be changed to suit the different cloths that are made, and still further, a cloth can be made of which one side is softer than the other. The filling thus becomes more prominent on one side than the other. This is known as "cover" on cloth.

A cloth with cover has a more finished appearance on one side than the other. It also has a softer feel on one side, because the filling predominates on that side. This apparently small matter does not receive the attention it should, but it can be unhesitatingly stated that a cloth with cover is of greater value than a bare or ordinary cloth, though both may be of the same structure. Whether the cloth is to be printed on one side before it is sold over the

counter, napped on one side, or sold as bleached or gray calico, its value will be increased because the printed figure will show better, the nap or fuzz will be longer, and the cloth will be more pleasing to the eye and the touch when the buyer examines it.

Fig. 58 shows a cam that is used principally on broad looms, and then only when the warp is made of strong yarn, for as this cam causes a long dwell of the harness, there must necessarily be a very quick change to compensate for the time expended. This sudden strain on the yarn plucks it somewhat, and would cause soft yarns to break. If the sizing compound has not laid the fibres properly the

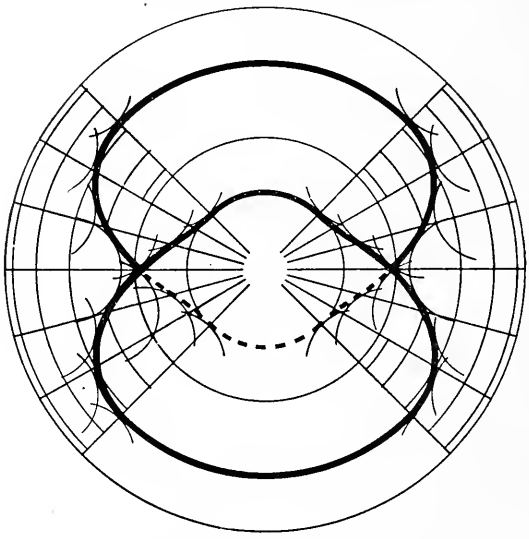


Fig. 57. Plain Cams, ½ Dwell.

yarn sometimes clings to the shed; to overcome this, a two-thirds cam is used, because the sudden opening of the shed draws the ends apart. The yarn should have been made from good stock or it will not stand this extra strain.

Result of Unequal Cams. If the stroke of the cam, or the amount of lift given to the harnesses, is not considered when changing from one fabric to that of an entirely different nature, in point of coarseness or fineness of yarns, the result will be disastrous. The cams are either too large or too small, straining the yarn by too large a shed, or making poor cloth by having too small a shed. If the

shed is too large there is too much friction in the working parts of the shedding motion, and the loom requires more power to drive it. When the shed is too small the shuttle flies out frequently, the cloth is rough looking because the filling cannot be drawn through properly, and bunches up in the shed; the selvedges are also very poor on this account.

The reason for changing cams is obvious; when weaving fine yarns or using fine filling, the smallest shuttle that can be used practically in the loom is the best, for a smaller shed can be made, and the finer filling is generally spun on a small bobbin or a small

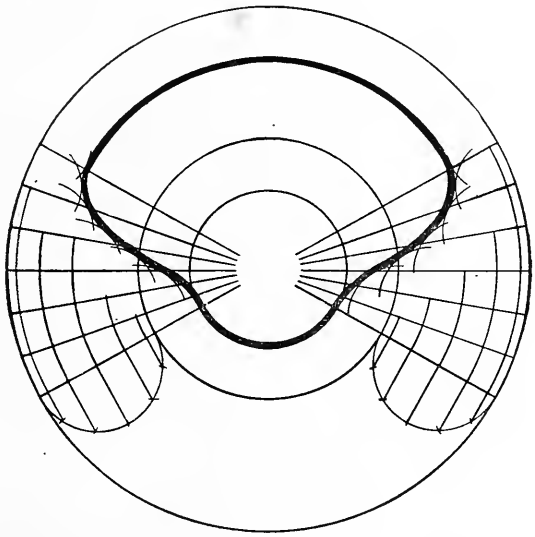


Fig. 58. Plain Cam, ⅔ Dwell.

cop. The finer the yarn the greater the quantity that can be placed in a given space. When coarse filling is used it is best to have as large a shuttle as possible in order that the loom may run a longer time without changing for a fresh bobbin. If the cop or bobbin were only large enough to fit a shuttle $1\frac{1}{2} \times 1\frac{1}{4}$ inches, the loom would run but a few minutes before more filling were required, thus causing a greater percentage of stoppages than necessary. This, of course, means a loss of production. A decided advantage is to be gained by changing the shuttle to suit the fabric that is being woven,

provided there is a considerable difference in the counts of yarn. If coarse yarns of a fairly good quality are being woven, it is far better to invest in a few shuttles that are $1\frac{5}{8} \times 1\frac{3}{8}$, and that will hold a 7-inch bobbin, than to use smaller shuttles that will only hold a $6\frac{1}{2}$ inch bobbin. The increase of running time for the loom will more than compensate for the cost of the shuttles. So with the changing to the smaller one, if finer yarns are being woven, the smaller shuttle will travel more freely through the shed, consequently less power is required to drive the shuttle.

Relation of the Treadle Bowl to the Cam. The treadle bowl plays an important part in correct treading. The size of the bowl will cause the yield of an even or uneven cloth in proportion to the cam. It also has an influence on the weaving of the yarn. When a small bowl is used the harness always jumps, or, in other words does not run smoothly. This is anything but desirable, because the yarn is plucked and this frequently causes thin places in the cloth. A small bowl is as bad as a rusty bowl or a worn plug (wood plugs are sometimes used on looms in place of the iron bowl) these being two of the worst features met with when shedding by means of cams. The defect arising from a small bowl becomes very conspicuous when there is a large boss on the cam, i.e., the portion that encircles the shaft. This causes a too pronounced depression on the cam where the rise commences; the small bowl drops into this, and their is a slight locking of the motion, which causes a jump.

A small bowl also shows its defect when the cam is made with a steep or quick rise; instead of the speed being gradually developed, there is a quick and sudden turn from the rise of the cam to the dwell.

A bowl of $\frac{3}{4}$ or 1 inch radius gives the best results, that is, for an outside or negative cam, but for a shell cam the size of the bowl is governed by the size of cam, leverage of the harness lever, and space at the loom, although on some looms the bowl is so small that one can see the harness lever jump. A small bowl and the stud on which it rests in a shell cam do not last half the time they should, both frequently wearing out. When they are worn, poor shedding is sure to follow, and also added strain on the straps or cords that connect the harnesses to the levers; for as the harness is actually controlled by the bowl and stud working in the lines of the

cam, there is a loss of lift when the harness is raised, and a loss in depression. To overcome these losses it is common to tighten the connections; but no matter how much they are tightened, there is never as good a shed as when the bowl and stud are in good condition.

Measurements of Shed. Before constructing a cam it is well to determine the amount of stroke required to lift the harnesses the requisite number of inches (Fig. 59.) If the harnesses are to be lifted 4 inches, what stroke of cam would be required?

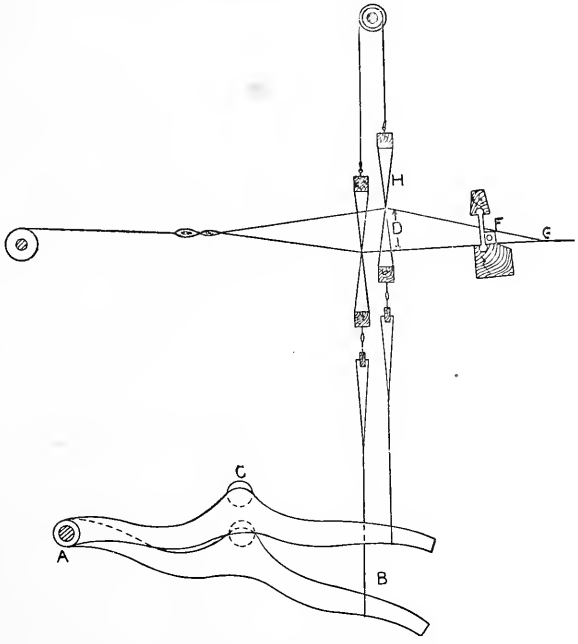


Fig. 59. Measurement of Shed.

Length of treadle from pin A to point of connection of harness strap B, is 24 inches. Pin A to treadle bowl C, 15 inches; required lift of the harness so as to give that space in the harness at D, 4 inches.

Rule: To find length of stroke, multiply the distance between the treadle bowl and the pin by the requisite distance at the front harness between its eyes when raised and the depressed portion of the warp to give a certain amount of shed; divide the above by

the length of the treadle between the pin and the point of connection of the harness strap.

$$\frac{15 \times 4}{24} = 2\tfrac{1}{2}''$$

The cam should have a $2\frac{1}{2}$ inch stroke.

To find the size of shed where shuttle passes through, using the above dimensions, proceed as follows (Fig. 59): Have the lay on the back center, and measure the distance from the top front of shuttle to the fell of cloth, F to G, also the distance from front harness to fell of cloth, H to G.

$$\frac{\text{A to B } 24'' \times \text{stroke of cam } 2\frac{1}{2}'' \times \text{F to G } 3\frac{1}{2}''}{\text{A to C } 15'' \times \text{H to G } 7''} = 2''$$

Therefore 2 inches is the size of shed where the shuttle passes through, but as about $\frac{3}{4}$ inch is allowed for the stretching of the straps, and as the motion is often set so that the treadle bowl is not fully in contact with the depression of the cam, this causes the shed to be only about $1\frac{1}{2}$ inches by actual measurement in the loom. What is the stroke (of cam) required for a certain size of shuttle? Shuttle $1\frac{1}{2}$ inches wide, $1\frac{1}{4}$ inches deep. Lay moves back 5 inches. Front harness to fell of cloth 7 inches. Length of treadle 24 inches. Pin to treadle bowl 15 inches.

Rule. Subtract the width of shuttle from the distance the lay moves back. Then multiply the distance of front harness from fell of cloth by depth of shuttle (allowing for the loss in the stretching of the straps, etc., $\frac{3}{4}$ inch), and divide by the remainder in the former subtraction. Multiply this result by length of treadle from pin to bowl, and divide by length of treadle. Result: stroke of cam required.

A $5'' - 1\frac{1}{2}'' = 3\frac{1}{2}''$

B Adding the $\frac{3}{4}''$ stretch of strap $7'' \times 2'' \div 3\frac{1}{2} = 4$

C $15 \times 4 \div 24 = 2\frac{1}{2}$; $2\frac{1}{2}''$ stroke of cam.

CONSTRUCTION OF CAMS.

Fig. 60 shows the construction of a cam with a $2\frac{1}{2}$-inch stroke. The stroke means the distance the cam moves the treadle at that point where it comes in contact with the treadle bowl. In the construction of cams approximate distances are used, but they are taken from those most generally used.

Dimensions for Fig. 60, a cam for making plain cloth, are as follows: Center of shaft (the shaft on which the cam is set) to nearest point of contact of the cam with the treadle bowl, $1\frac{3}{4}$ inches. Dwell to be one-half the revolution of crank shaft.

Describe the first circle, with radius of $1\frac{3}{4}$ inches; add to this 1 inch, the radius of treadle bowl, and which will be the center of movement of the treadle bowl in marking off the shape of the cam; add to these the stroke of cam $2\frac{1}{2}$ inches. There are now three circles.

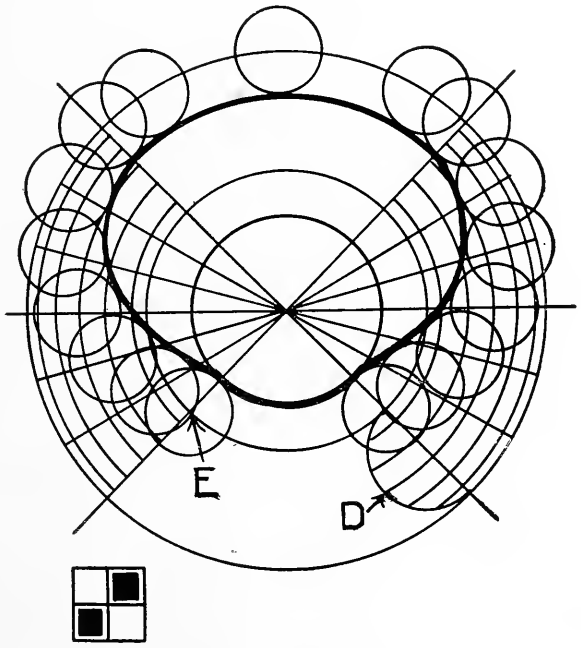


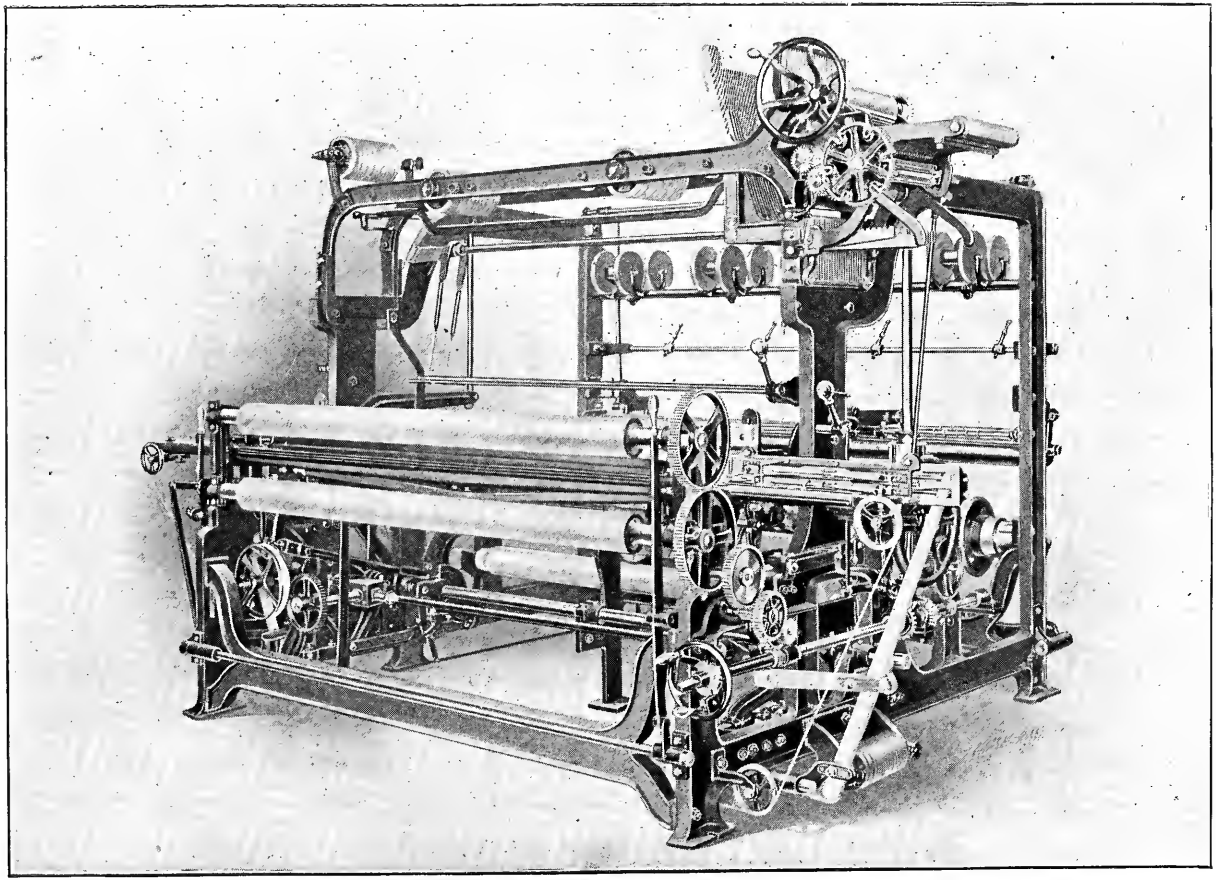
Fig. 60. Plain Cam.

To make plain cloth two cams are necessary, the pattern being made on two picks. Whatever number of picks there are to be to the pattern, there must be as many cams to the round, or one revolution of the cam shaft. Sometimes when weaving fancy cloth more harnesses are required to make the pattern than there are picks in the pattern, and there must be a cam for each harness, yet the cam shaft makes but one revolution to one repeat of the pattern. Plain cloth is almost always woven with two harnesses, and when

four are used two are fixed together, these being controlled by one treadle and one cam. The three circles described must be divided into as many parts as there are picks in the pattern, but when each end in the pattern is lifted or depressed in the same manner to form the pattern, only one cam need be constructed to show what is required for the rest. Whenever one or more threads interweave differently from the rest, a cam must be constructed for each different set of threads. This is shown in the different figures of constructed cams.

The diagram shows that both threads are to be woven in a similar manner, but that one thread is up when the other is down, thus requiring the setting of one cam opposite the other, as shown in Fig. 54. The vertical marks show how the ends are to be lifted; the horizontal lines show how the filling is placed in the warp. Read the diagram or design from bottom to top, and construct the cam accordingly. As there are two picks to the pattern, divide the circles in two parts, one part for one pick, one part for the other pick (Fig. 61).

The dwell required is now partitioned off. The dwell, whether it is $\frac{1}{3}$, $\frac{1}{2}$, or $\frac{2}{3}$, must be divided from each individual part, and the center of these parts must also be divided. One-half dwell is required: divide each part into four; take the two center ones, leaving a quarter on each side. The remaining quarter left on the side of each dwell portion must now be divided into three equal parts; the two quarters coming together, show them to be divided into six equal parts. (Fig. 62). The reason for taking up the portions that are left after the dwell is marked off, is that in the shedding, one harness is being raised while the other is being depressed; the cams must be constructed in such a manner that a portion of the rise of one will overlap a similar portion of the depression of the other. After dividing the portions mentioned into six equal parts, the space between the outer circle and the radius of the treadle bowl must be divided into six unequal parts, commencing in the center, and having the two largest spaces on either side, the succeeding ones becoming smaller as they near the circles. (Fig. 66). This method of construction gives a quick start to the harness, then gradually slows down when nearing the dwell, and yet performs the motion without sudden jumps. Figs. 63, 64 and 65 refer to various dwells.



VELVET LOOM FOR ONE OR TWO SHUTTLE WORK
Crompton & Knowles Loom Works

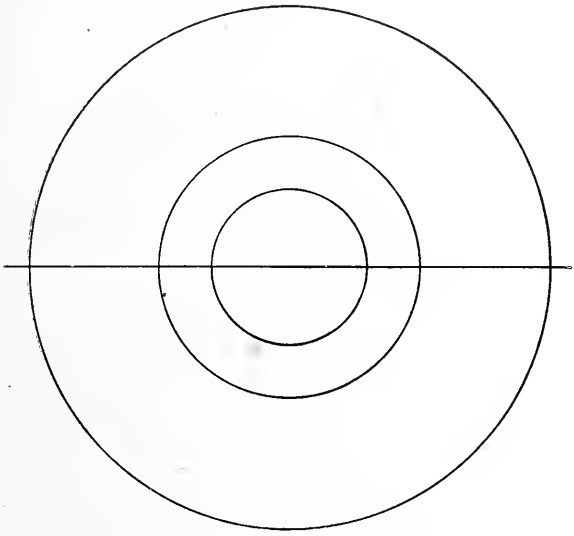


Fig. 61. Construction of Cams.

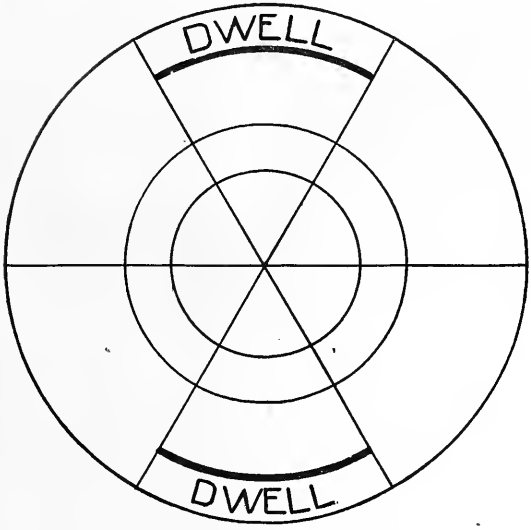


Fig. 62. Diagram for $\frac{1}{8}$ Dwell.

To obtain the six unequal parts, describe a half-circle between the two outer circles, and divide this half-circle into six parts. As each point of division is considered as a part of the circumference of a circle whose center is the same as the center of the outer circles, this will give, as shown in the sketch, six unequal parts, D. When this has been accomplished make half-circles or circles the size of the radius of the treadle bowl. Start these circles at the point marked E, and continue to describe them at the further corner, advancing towards the outer circle. Also construct several circles on the outside circle, and follow down on the opposite side, until opposite the starting point. These circles represent the treadle bowl passing round the cam. After the circles have been described, draw a thick line inside and just touching the circles, and also make the outer portion of the inside circle deeper, so as to correspond with the thick outline which represents the cam.

In brief, the construction is as follows: Describe the circle according to dimensions given. Divide these into as many parts as there are picks in the pattern. Subdivide each portion of the dwell required, having the dwell in the center, and the remaining portions left from each dwell divide into three equal parts, bringing six parts together. Again divide the space from the outer circle to the radius of the treadle bowl into six unequal parts with the widest in the center, narrowing down the spaces to the outer and inner circles. Describe the radius of the treadle bowl at the opposite corners of the divisions, starting at the inside circle for the treadle bowl, and passing to the outside circle. Finish by making the thick line representing the cam, touching the inside of the circles.

To obtain the best results, it is conceded by the majority of those who understand cam shedding, that one cam should be a trifle larger than the other in the stroke, and the other cam larger in the depression or smallest part. This is owing to the method of connecting the harness straps with the treadles (see Fig. 54). The treadle at the point of connection with the front harness strap descends lower and also rises higher than the other treadle connection, which would mean, if equal cams were used, a higher lift of the front harness; whereas the law of shedding demands that the back harness have the greatest amount of movement, on account of its being a greater distance from where the shuttle passes through the shed.

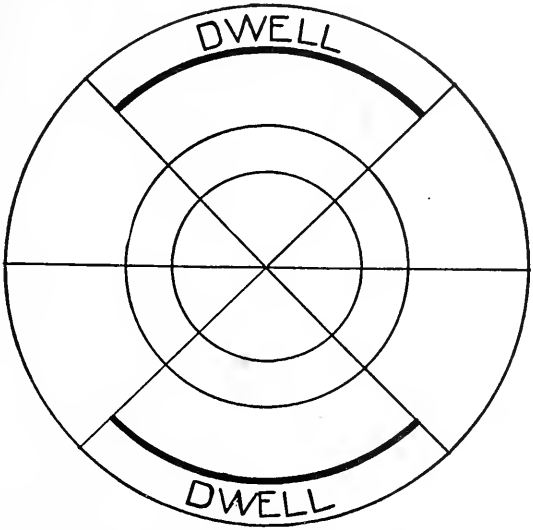


Fig. 63. Diagram for ½ Dwell.

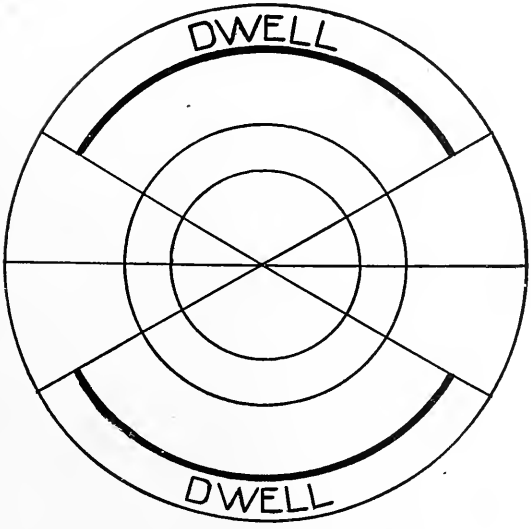


Fig. 64. Diagram for ⅔ Dwell.

To give the correct shed, the larger cam controls the treadle for the back harness, and the cam with the largest depression is placed over the front-harness treadle. The front harness is also connected with the smallest set collar on the harness roller.

When the back-harness treadle is pressed down by the larger cam, the front-harness treadle is raised. This would give a very large lift to this harness, owing to the connecting point, if it were not for the larger depression and the smaller set collar. When the front-harness treadle is depressed by the smaller cam the connecting point descends lower, consequently the back harness is raised higher. The strap of this harness is connected with the large set collar. The back cam is generally made $\frac{1}{8}$ of an inch larger in stroke, and the front cam $\frac{1}{8}$ inch larger in the depression. When any changes are being made, it is necessary that care should be taken in setting the cams in the right manner, or very poor and uneven shedding will be the result.

There are three different methods of setting the shedding motion; namely, first, having the back harness raised when picking from the left-hand side of the loom, no matter whether it is a right or a left-hand loom; second, having the back harness raised when picking from the box opposite the filling stop-motion, or shipper-handle side; third, having the back harness lifted when picking from the shipper-handle side. In some mills there is no system whatever, the only requirement being that the large cam is on the back treadle. The latter scheme is not commendable, for any one of the three methods, among which there is scarcely any choice, is preferable to no system.

There are three essentials for good shedding; namely, harness roller level, having the set screws parallel from back to front, F' F, (Fig. 67); harnesses level, E; treadles level, B. When the reed is about 2 inches from the fell of the cloth, and the crank shaft is in the position shown at D (Fig. 67), the three parts mentioned should be level. But whether the shed is level at the fell of cloth, or three inches back, the three essentials must be attended to or the result will be unequal shedding; for if the treadles and harnesses are level, and the set screws on the harness roller are not parallel, one strap will wind on the other when the shed is wide open, and the other strap will not wind round far enough. The result is uneven shed-

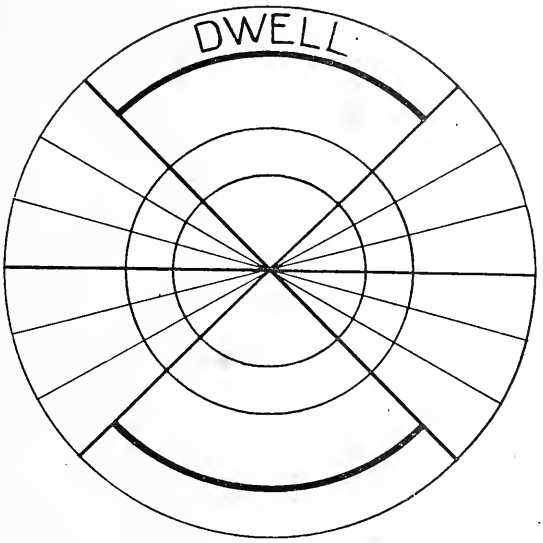


Fig. 65. Second Step in Building ½ Dwell Cam.

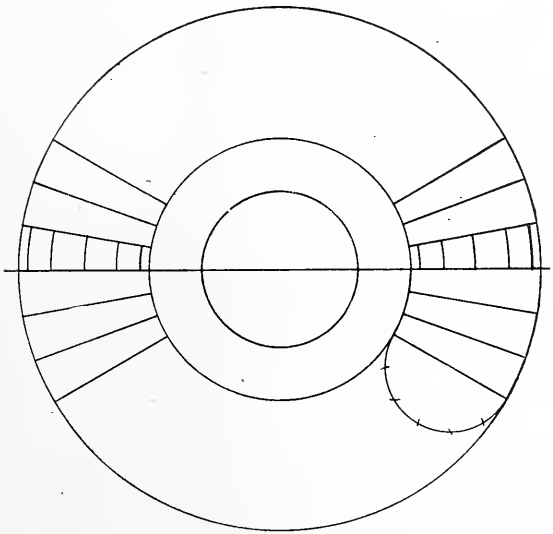


Fig. 66. Construction Lines.

ding and a jump to the harnesses. If any one of the three parts is not level when the rest are, the results are uneven cloth, yarn broken out, and very poor shedding. A greater or a smaller number of picks can be placed in the cloth, according to the way in which the harnesses are set. With a shed level when the reed is from two to three inches from the fell of the cloth, the shed is more open when the beating up takes place, consequently the picks are held more firmly in the cloth and are beaten up closer, and, moreover, there is

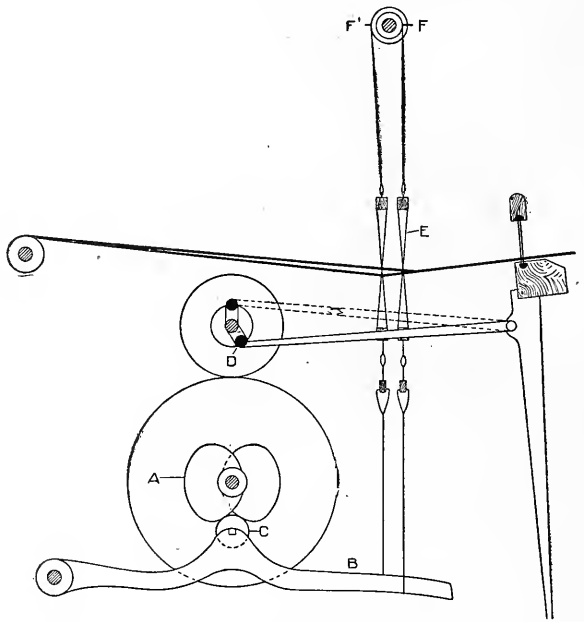


Fig. 67. Position of Cam When Shed is Closed.

only one pick to beat up at a time; but with a shed which is not so open, the picks are not held firmly, and spring back so that the lay has to beat up several at one time. This makes it impossible to have as heavy a cloth as in the former case.

When setting the harnesses, before the yarn is tied to the apron or leader, they should be in such a position as to allow the yarn to rest upon the race when the shed is first opened, because when the filling is put in the shed it is closed, and this lifts the yarn up from the race plate. Thus, if the harnesses are set high at first, they have to be changed as soon as the filling is placed in the shed.

Fig. 68 shows a loom with the cams fixed at the side of the loom. The harnesses are connected with the quadrant lever, which is fixed to the supporting bar. A small arm is fixed to the back of the supporting bar, but at one end. A rod connects the arm with the treadle. The cams are on a sleeve, placed on the pick cam shaft, and to the sleeve a large gear is attached. In the diagram this gear has 120 teeth. A gear with 30 teeth is fixed on the crank shaft,

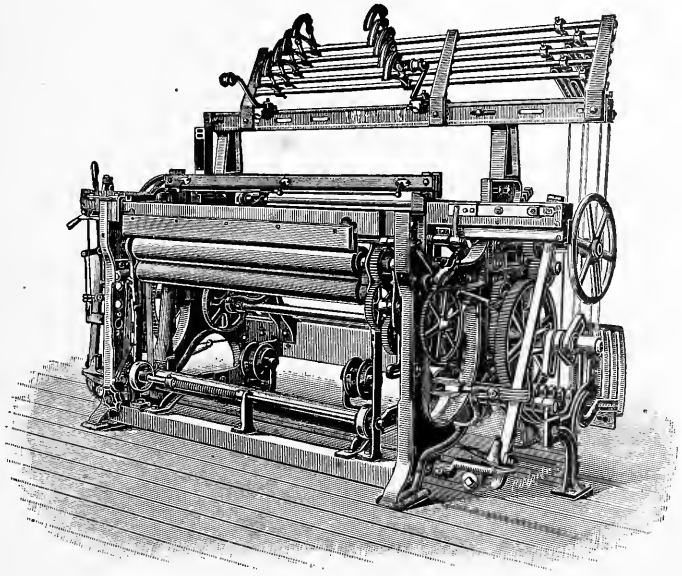


Fig. 68. Loom with Cams on the Sides.

and through an intermediate it imparts motion to the cam gear. This gearing is set for a four-harness twill, whether one up and three down, or two up and two down. (See cam in Fig. 69.)

As explained in the construction of cams, one revolution of the cam equals the number of picks to the pattern; so that the gear fixed to the crank shaft must divide as many times in the large gear as there are picks to the pattern: $120 \div 30 = 4$. This is one of the simplest motions for shedding by means of cams, and is very easily fixed. It is in direct contrast to the roll-top motion shown in Figs. 70 and 71. The least change on any harness in this motion alters the rest, for owing to the method of connecting the harnesses they are dependent upon each other.

The rollers are made with different circumferences. The smaller rollers are rather small, and would be far better if they were larger in proportion to the lift, because the strap winds on itself when the harness is lifted, with the result that there is a constant jumping of the harnesses. This is of course detrimental, especially to fine yarns, for when the strap unwinds it is almost pulled off the roller. Sometimes the straps do come off and drop on the yarn. The cams are

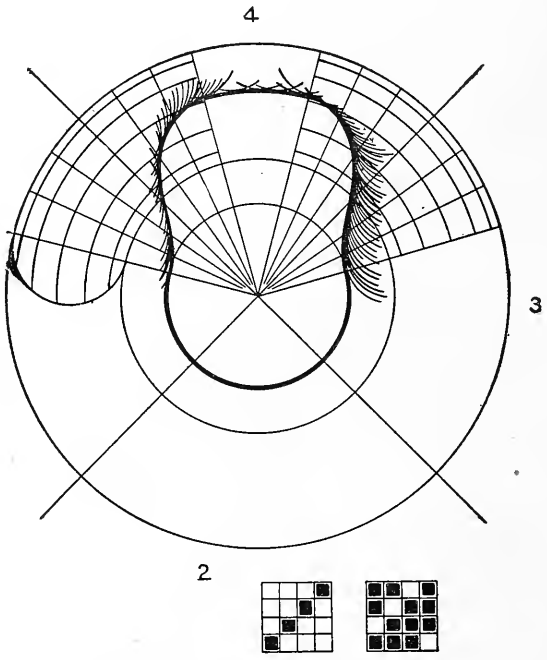
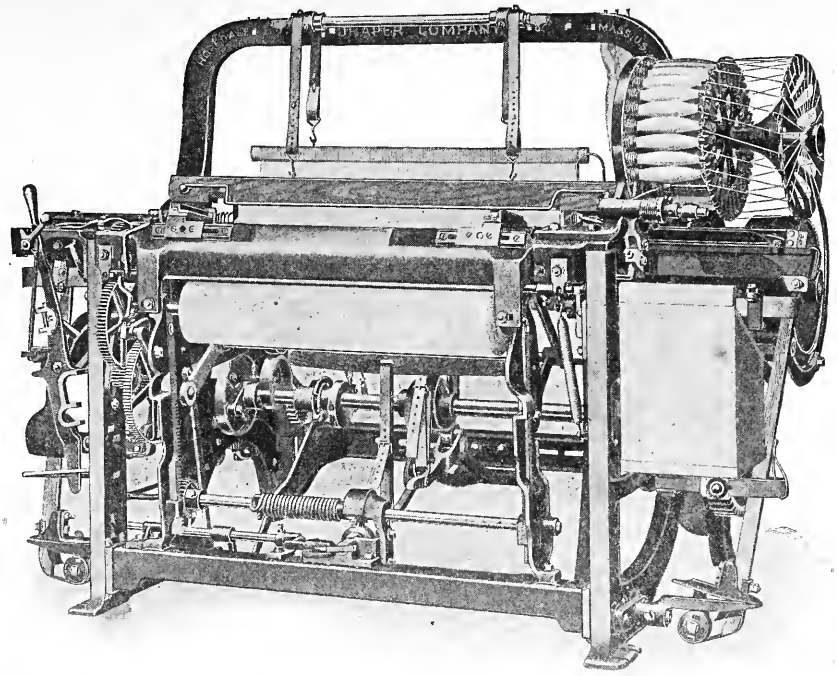


Fig. 69. Four Harness Twill Cam.

graded, the smallest having $1\frac{7}{8}$ inches stroke, the largest $2\frac{7}{8}$ inches stroke. It requires a considerable amount of skill in the setting of these motions, but when they are set they give fair results. Yet the time spent in setting is not balanced by these results. When compared with the motion in Fig. 68, it is seen that one is placed inside of the loom and out of the way, while the other is outside the loom and apparently requires a greater amount of space; yet the outside motion is out of the way, being behind the box, and is certainly much easier to get at.



NORTHROP LOOM SHOWING FILLING CHANGING DEVICE

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The cams for the roll top motion are fixed on an auxiliary shaft, and the shaft receives motion from the pick cam shaft. The same rule applies when calculating the gears that drive the cams, except

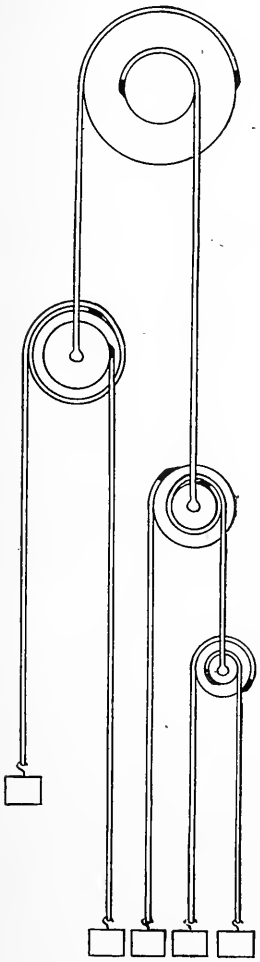


Fig. 70. Roller Motion.

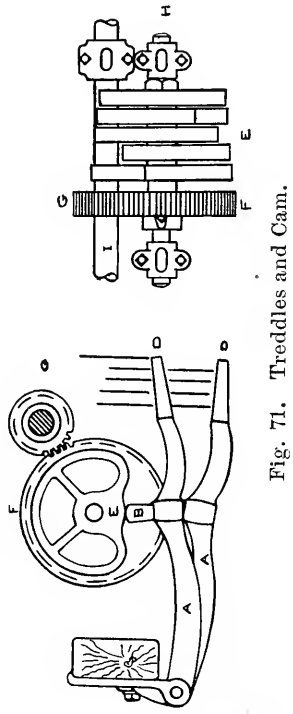


Fig. 71. Treddles and Cam.

taking into consideration the shaft from which the power is derived. The pick cam shaft travels half the speed of the crank shaft, so that two picks of the pattern are placed in the cloth while the pick cam shaft revolves once; thus the gear fixed to the shaft must contain

two and one-half times less teeth than the gear on the shedding cam shaft, that is, for a five end satin or twill cloth. (See Fig. 72.)

If there is a gear of 70 teeth on the shedding cams, and a gear of 35 teeth, one-half the size, is placed on the pick cam shaft, the cams would travel at the rate of one revolution to four of the crank shaft, which would leave one pick out of the pattern. But if a 28-tooth gear drives the 70, there would be one revolution of the cams to five of the crank shaft.

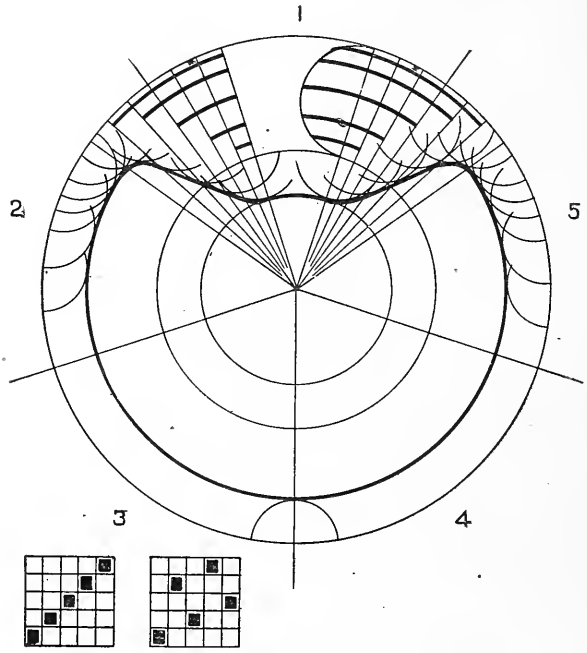


Fig. 72. Harness Sateen or Twill Cam.

Example. There is a 30 driving gear on the crank shaft, imparting motion to a 60 gear on the pick cam shaft; a 28 gear on this shaft drives a 70 on the shedding cam shaft.

If there is a four-pick pattern, what number of teeth should the gear contain using three of the above gears?

Ans. A 56 on the shedding cam shaft.

THE PICKING MOTION.

This is the motion that consumes about $\frac{7}{10}$ of the power required to drive an ordinary easily running loom. A careful overseer or

fixer should see that this motion is giving the best results for the power expended. It is a very easy matter for the pick motion to be so fixed that the loom actually takes $\frac{1}{4}$ horse-power more to run it than would be necessary if the motion were set correctly.

As already stated, some fixers believe that the pick motion causes the uneven movement of the lay. It is undoubtedly a fact that through the faulty setting of the pick motion the lay is checked;

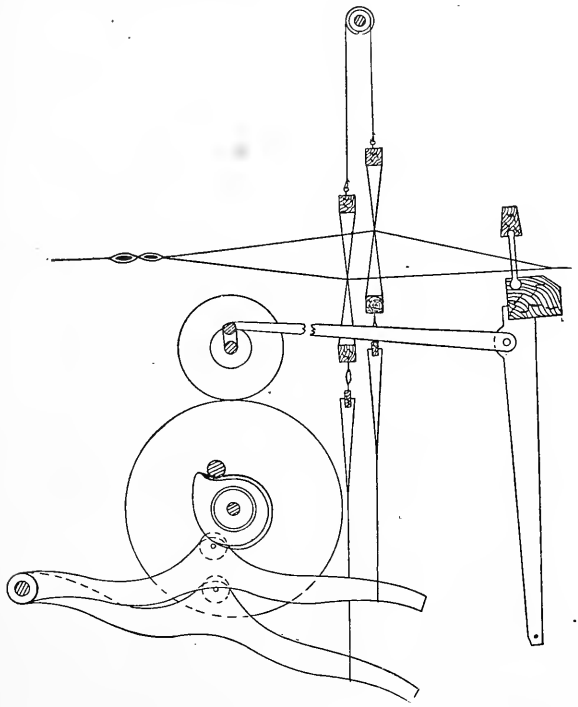


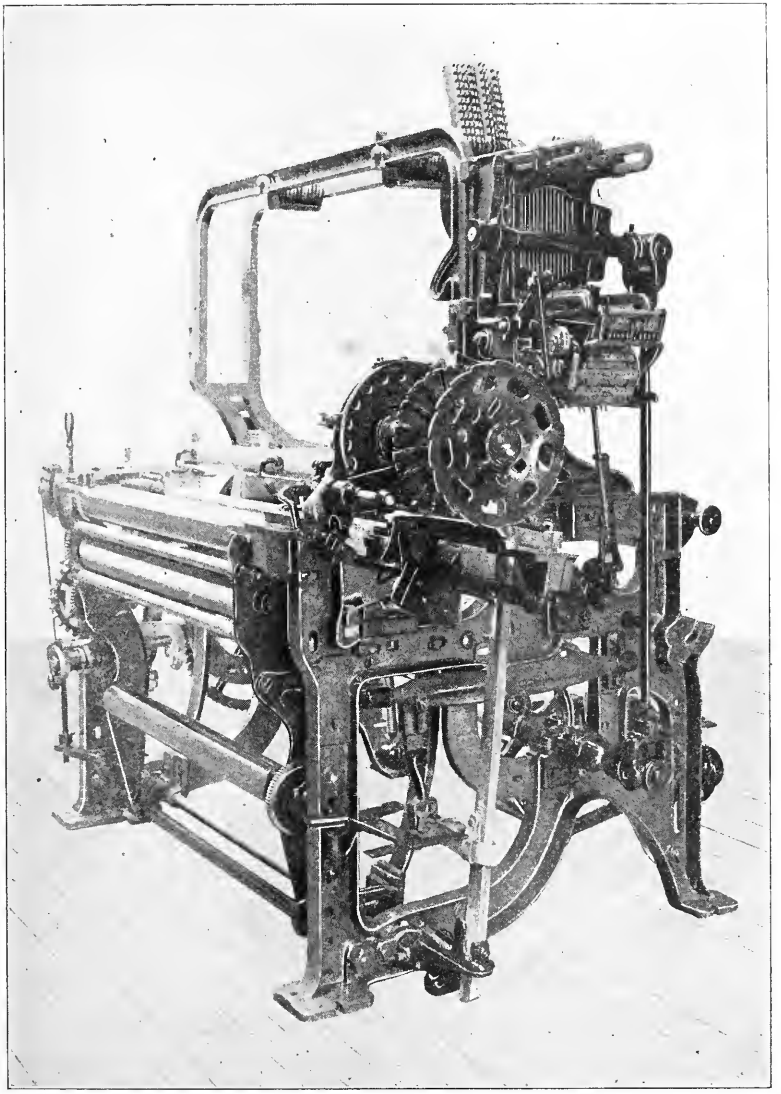
Fig. 73. Diagram Showing the Setting of Pick Motion.

but if the motion is understood, together with the reason for the shapes of its various parts, there can be little or no perceptible check on the lay. The placing of the hand on the lay cap is one of the best ways of telling whether or not the pick is working at its best. The pick motion is, or ought to be, constructed in such a manner as to give a gradual development of speed as in Fig. 73; starting slowly, gradually increasing the speed, until as the shuttle is leaving the binder the full power is applied. Such motions give the best

results, fewer supplies are used, and the loom lasts longer. To thoroughly understand why this is better the following explanations are given:

In the first place the shuttle is held in a confined space by pressure applied through the binder; no matter what style of binder is used, the pressure remains on the shuttle for a shorter or longer period of time. This being so, it is utterly impossible to give a sudden blow to the confined body, namely, the shuttle, and then have it enter the opposite box in the manner in which it should, that is, slide in straight without striking the front entrance of this box. Of course it is taken for granted that the student is aware of the fact that a shuttle box is a trifle wider than the shuttle, and that there is no confining of the shuttle from the time it has left the binder until it has reached the shed formed by the yarn. As a proof of the foregoing statements, the following test is presented: Observe two looms, one with a quick, hard pick, the other such as the one already described, and compare the shuttles after six months' running. On the latter, the shuttles will be smooth, and in almost as good condition as when they were first used, excepting, of course, the natural wear; whereas, in the former, the shuttles will have been chipped to a greater or less degree, caused by their flying out or being driven hard into the opposite box. Another proof: Suppose a shuttle does not get wholly into the box, but stops a short distance from the picker, and yet is in far enough to keep the loom running; under these circumstances, one can hear the shuttle rattle in the opposite box, striking where it should not, or else see it thrown out of the shed. This is caused not altogether by the shuttle being a short distance from the picker, but mainly because the power has been suddenly applied to the shuttle, and it has received a jar that is not beneficial to its correct running.

Some fixers who have charge of looms on which the picking shoes have a long sweep, set the ball so that it will strike the shoe half-way up the incline, or, in other words, at the commencement of the steepest part of the shoe, with the result that there are innumerable smashes caused by the shuttle becoming chipped, the spindle stud constantly wearing out, and the binder never giving good results, because of the pin becoming worn. The same results follow to a greater or less degree on the "Cone Pick": if the cone is set



DOBBY LOOM WITH NORTHROP FILLING SUPPLY
Mason Machine Co.

down on the back, or if the shaft is set in too close to the pick cam, or, as sometimes happens, the cone is out of proportion to the pick-point. In view, then, of the above-mentioned facts, and the adoption of the shape of binder recommended, the best results are undoubt-

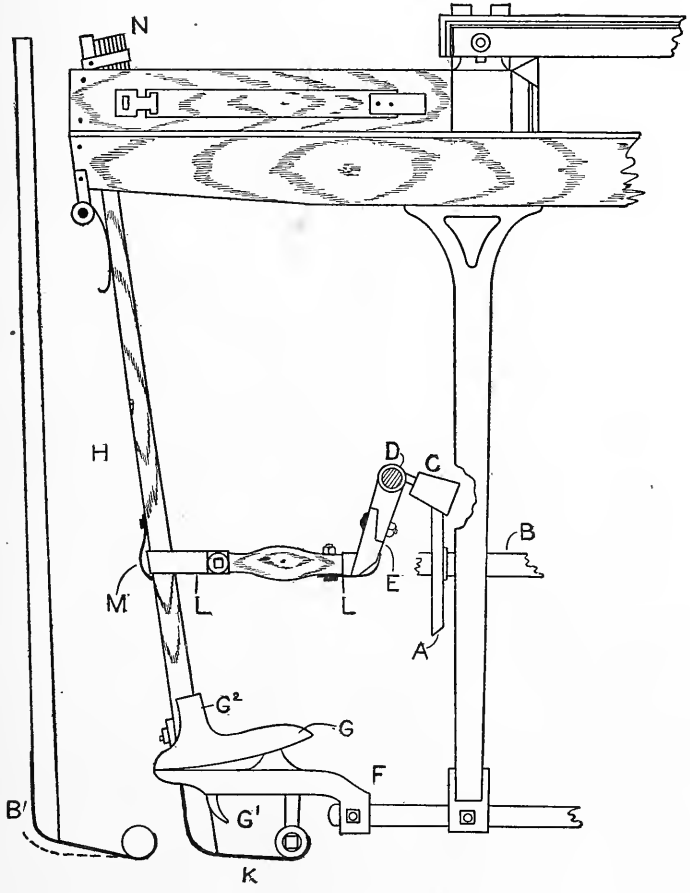


Fig. 74. Cone Pick Motion.

edly obtained by applying the power gradually, so that by the time the full force is acting on the shuttle, it will be leaving the binder, and yet the binder will have helped to keep the shuttle in contact with the back of the box, so that if guided straight from the first, there is no reason why it should not run into the opposite box cor-

rectly, unless something is out of order apart from the pick motion.

Cone pick and attendant parts, Fig. 74.

A. Pick cam fixed on a pick-cam shaft.
B. Pick Shaft, which is held in position against the side of the loom.
C. Pick Cone supported on stud fixed to the pick shaft.
D. Picking arm, fixed at the opposite end of the pick shaft, and which descends.
E. Dog, placed at the lower end of the picking arm.
F. Picking stand, fixed to the rocker shaft.
G. Picking Shoe, rests on the picking stand.
G^1. Tongue fixed to the shoe.
H. Picking stick fixed to the picking shoe, and which passes through the stand.
K. Heel strap which connects the picking stick to the spring K^1.
L. Short lug strap.
L^1. Long lug strap.
L^2. Sweep, or power stick; the ends of the lug straps are connected to the power stick; the short lug passing around the inside of the dog, and the long lug passing around the picking stick.
M. Stirrup strap; this strap keeps the long lug in position on the stick.
N. Picker fixed on the top portion of the picking stick.

The cone pick is undoubtedly one of the best picking motions for single box looms. Apart from the special cams already spoken of, the cam described in Fig. 75 is the best one that can be recommended: it gives the easiest possible stroke, and less power is required to drive the loom; the loom also runs easier than if it were fitted with a pick cam such as shown in Fig. 76.

Fig. 75 shows a cam with different diameters; that is, instead of being circular up to the pick point, it is cut off, commencing a little below the back center, almost to the beginning of the pick point; about one inch is taken off at the smallest diameter. This shape of cam gives a gradual development of power, which, as already explained, is preferable to the sudden blow. Instead of the cone suddenly meeting the point, it is first lowered, then gradually raised.

The shape of the pick point enters very largely into consideration in determining the value of the pick motion. The cam may be of good shape and size, but if the pick point is too abrupt, the hollow too much defined, or the extreme end of the point too narrow and receding, the results are as bad as from an imperfectly constructed cam. The abrupt point gives a very harsh, hard finish to

the pick, tending to throw the shuttle crookedly. The hollow being too well defined tends to lock the cone, giving a jump to the motion which often breaks the picking shaft; the pick cam is also sometimes loosened by this fault, and such a point requires more power behind the motion. When the extreme point is too narrow and receding, a soft pick is the result (not an easy pick), lacking the firm finish to the motion; such pick points frequently cause trouble, for the loom bangs off at the least change of atmosphere. The best pick point is the one that is at least $1\frac{1}{2}$ inches at the end, with the

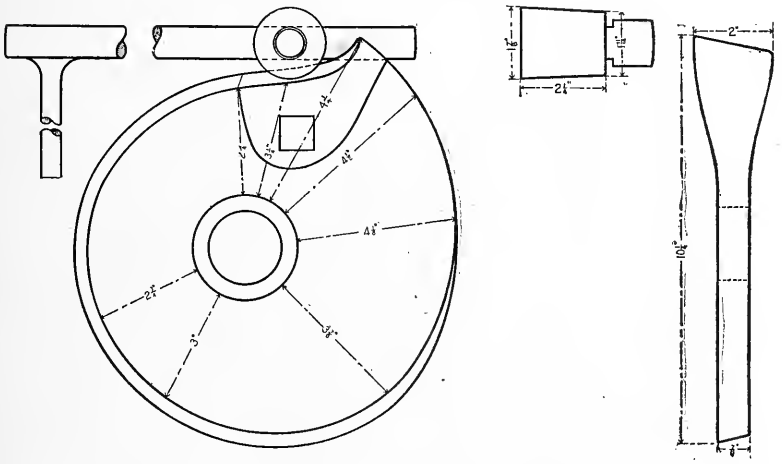


Fig. 75. Dimensions of Cam and Cone.

extreme inside edge about $\frac{3}{8}$ inches higher than the other edge, and slightly inclined backwards. It would do no harm to have the point 2 inches in width at the extreme end.

A large cam gives better results than a small one, as the cone fits better, and a smaller and better shaped pick point can be used: it is unnecessary, also, to have the point so much depressed. The diagram given in Fig. 76, illustrates one of the best cams of this type.

Almost invariably with a cam of this nature, a large pick point is used, and to correspond with it a very large cone is necessary, which means the expenditure of more power when in motion. If the outer end of the cone is considerably lower than the shaft, it is not an advantage, especially with such a large pick point, as

it must of necessity give a hard pick, beside requiring more power to lift it.

Relation of the Cone Pitch. Unless the cone is in proper proportion to the cam, uneven picking will follow. If the cone is too small, it locks in the hollow of the pick point; if it is not tapered to the right pitch, only a small portion of the cone is in contact with the cam. If it is too large, it does not enter the hollow of the cam, and a sudden motion is the result. For the best results, the cone should be set between the back and top centers of the cam, but

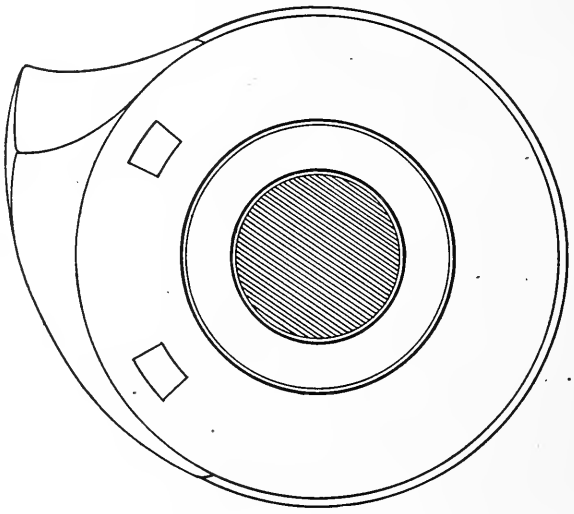


Fig. 76. Circular Pick Cam.

slightly inclined to the top. If too near the top of the cam when motion is imparted to it, the cone slides away from the point, and does not receive the firm blow that gives a good pick. When placed toward the back center of the cam, the point locks on the cone with very poor results. The cone ought to extend over the edge of the cam, when resting on the back center, at least three-quarters of an inch; the top of the cone should be almost level at this point, so that when the cam works around, all, or almost all, of the outer end of the cone will be in contact with the point.

Dogs on Picking Arms. There are three distinct kinds of

dogs used on the picking arms; (Fig. 77) A, B, C. A is certainly the better; there is almost a straight pull on the lug strap, which means that the strap will last longer. B and C cause the straps to crack and break on the edge, because all the power is exerted at one point, instead of at the full width of the leather.

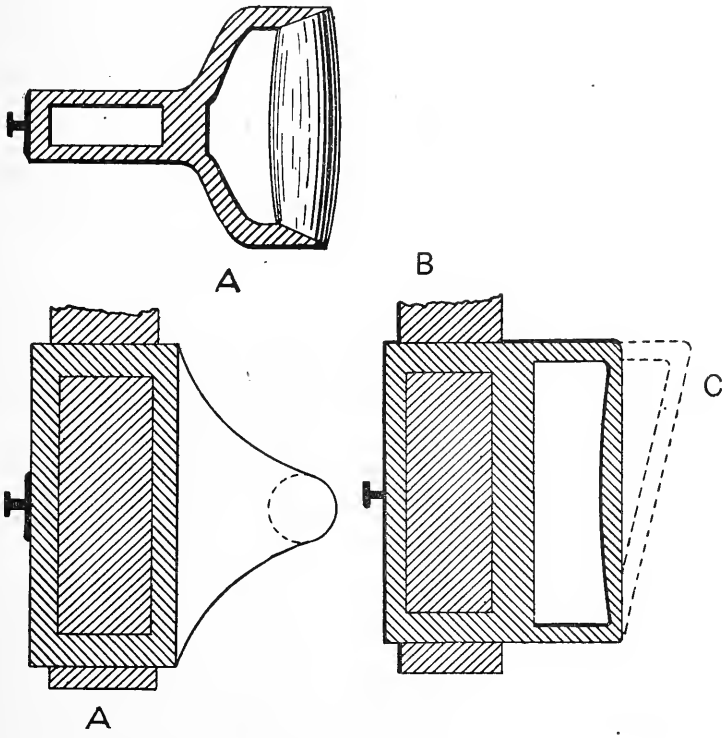


Fig. 77. Picking Dogs.

Lug straps will last ten times longer by the use of A than they will by using B or C.

Picking Stand and Shoe. This is called the Stearns parallel motion. When fixing the picker stand to the rocker shaft, care should be taken to see that the picking stick moves freely in the box, changing the motion of the lay to test this. The stand can be fixed while the lay is on the front center; when it passes to the back center, if there is a slight binding of the picking stick, it will influence to a marked degree the running of the shuttle. Several

bad effects result from the poor fixing of the stand. Unless it is set in the right position, the shoe will not work parallel to or flat on the stand, with the result that as the picking takes place, the edge of the shoe instead of the sole is working: this causes a slight twist of the picking stick, which eventually throws the shuttle crookedly across the lay, beside requiring more power to drive the stick, owing to its binding in the race. If the shoe is allowed to work in this manner for a short time, a ridge is worn on the projection fixed to the stand, so that occasionally the shoe rides on this ridge, and causing the stick to jump, suddenly raises the shuttle on the back, thereby cutting the filling, and sometimes throwing out the shuttle. A small plug of wood or iron is driven into the stand, the outer end acting as the fulcrum for the tongue G^1. This plug, when made of wood, is likely to be driven in crookedly, and, if this is the case, the results are almost identical with those which come from the incorrect setting of the stand. The crooked plug twists the picking stick, throwing the back of the shuttle either too far from the back of the box or into the box back, forcing the front end of the shuttle out from the reed, thus causing a crooked running shuttle or a flying one.

If properly made and handled, the wood plug is undoubtedly better than the iron one, for it is easier as a friction point on the tongue. Wood plugs cost very little because they are generally made from scrap timber, yellow pine being preferred. They are cut so that the tongue rubs against the grain. These plugs should be kept in oil, when it is remarkable how long they will last. Wood is preferable to iron, owing more or less to the careless handling of looms by weave-room help. There are careless weavers in every mill, and many of them rarely oil the picking stand, so that there is a natural tendency for the friction point between tongue and plug to become dry. If the plug is iron, it becomes rusty, causing the stick to jump, but the wood plug yields to the action of the iron tongue. It takes a long time for a wood plug to become dry, if it has been thoroughly soaked in oil before being placed in the stand, and the constant friction makes the end of the wood very smooth. A wood plug will last almost as long as an iron plug, with the advantage that the tongue is very little worn.

Whatever kind of motion is in use, whether as already described,

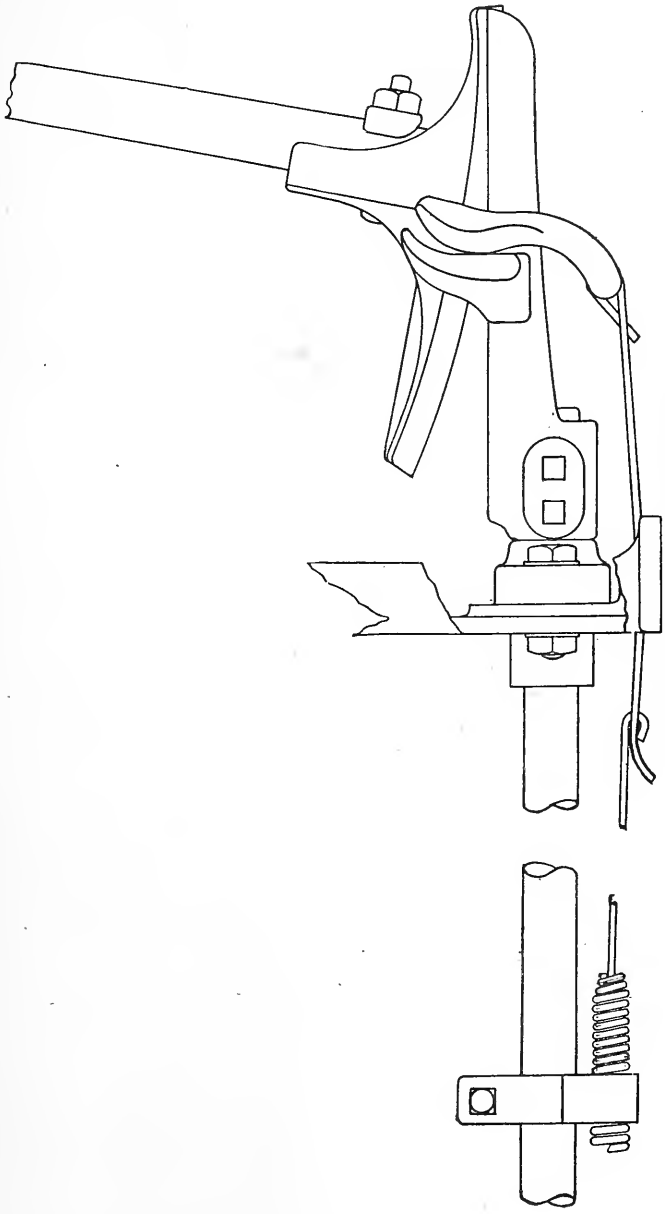


Fig. 78. Parallel Picking Motion.

or as shown in Figs. 78 and 79, the two points must be set as straight as possible, in order to avoid a twisted picking stick.

The mechanism shown in Figs. 78 and 79 has somewhat of a rocking motion, and is used very extensively on Mason looms. It is claimed for this style of shoe that it will stand a high rate of speed. The rest of the motion is similar to Fig. 74.

Setting of the Picking Stick and its Connections. There are two distinct ways of setting the picking stick: the first as shown in Fig. 74; the second as in Fig. 74, B′, having the bottom of the picking from $\frac{3}{4}''$ to $1\frac{1}{4}''$ higher than shown.

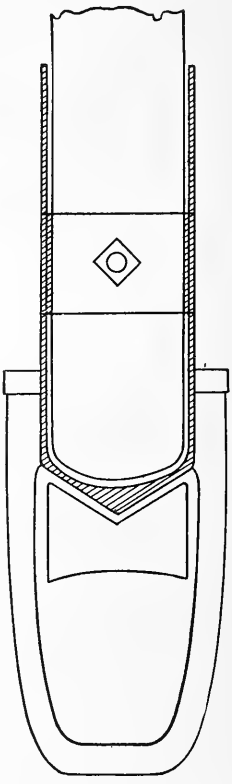


Fig. 79. Cross Section of Picker Stick and Shoe.

The first is considered better. Set the stick so that it will be about $\frac{1}{4}''$ above the level of the heel strap K, or so that the bottom of the stick is not below the level. This is what is termed a controlled picking stick; that is, when the strap is connected to the stick and attached to the spring in the right manner, after motion has been applied to the stick it will return almost to the end of the box. This necessitates, in all probability, the use of a check spring, or a double piece of leather, but the cost of either of these is small in comparison to the gain. (The chapter on binders should be studied in connection with this portion of the picking motion, as both enter into very close relationship, for understanding one without the other destroys the possibility of the best results.) When the stick is fixed in this manner, in the majority of cases a round hole in the picker is formed by the shuttle tip striking it. It is a well-known fact that a round hole in the picker denotes that the shuttle is running correctly, because a round hole cannot occur if there is the least tendency for the shuttle to rise. Any rise of the shuttle is generally caused by its running crookedly from box to box. The

picker will last longer if it is being worn as described; this is the first gain. Secondly, the picker band or collar, that fixes the picker to the stick, is rarely loosened on the stick under such setting, because the shuttle strikes squarely against the picker. Thirdly, there is no possible loss of power as the shuttle is being driven from the box; besides, the shuttle is thrown just as the motion is set to throw it; this is impossible with a picker that has a slot cut in it instead of the round hole.

When a picking-stick is loose in the box, as it invariably is when fixed after the second system, it remains from $1\frac{1}{2}$ inches to $2\frac{1}{2}$ inches from the back of the box, consequently, the shuttle must drive back the stick to its right position, so as to get the full force of the picking motion. The picker, which in the majority of cases is made of leather, also receives considerable of the force of the shuttle; this naturally causes the picker to wear out quicker than it should; another disadvantage consists in the shuttle cutting a slot in the picker when driving back the stick, because it slides a little on the face of it, owing to the picker not being on the same plane with the tip of the shuttle, as it is when the stick is back. The sliding of the shuttle at this time will often cut the filling, and it frequently loosens the collar around the picker; a loose picker of course is not desirable. When the picking stick is driving out the shuttle, the slot already made in the picker by the shuttle, reacts on the running of the shuttle. (To understand this clearly refer to the binder.) The shuttle is held in the box by pressure from the binder; there is also pressure being applied to the back end of the shuttle by the picking stick. Consequently, it is perfectly natural under the circumstances that the picker should slide up on the tip of the shuttle. This is a loss of power; it may be small, but it is a loss, and these small losses count where there are a good many looms. There is also a tendency for the shuttle to be down at the back, which means either a flat running shuttle or a high front end, either position being incorrect fixing. Under these circumstances it can readily be seen that the tighter the heel spring is, the more power must be applied to drive the picking stick, owing to the greater resistance. By the actual setting of the stick in the second method, the force of the spring is off when the picking stick is about 2 inches from the end of the box, so that when movement is given

to the stick it travels this distance before it meets with the resistance of the spring. The heel spring should be set so that there is just sufficient strength on it to pull back the picking stick.

It has been computed by good authorities that the first setting combined with the shape of the binder described requires less power from the motion to drive the shuttle across the lay. Some picking motions, combined with the style of binder that is used, either necessitate a swinging picking stick or a very strong check on the end of the box.

Fig. 80 shows a motion that requires the above, but if the binder were changed so that there would be more taper and less bluntness, the picking stick could be set according to the first method, and the results would be considerably better than at present. The reason why such setting is demanded on Fig. 80 is because it is a blunt pick, the power being applied suddenly, with no gradual development of speed; and to prevent the shuttle driving through the end of the box, very strong resistance must be applied.

Setting of the Connections. After the picking stick has been set to the stand and shoe, the lug straps are connected. A sweep stick from 6 inches to 7 inches in length is used, to connect the lug straps. This stick should be of sufficient thickness, so that when the lugs are fixed, there is as much space between the straps as the thickness of the picking stick or the width of the dog; this allows perfect freedom. The using of short and long lug straps is simply a matter of choice, some preferring to have the straps of equal length, while others prefer a short and long lug strap, as is the preference of the writer.

When the dogs B or C are used, (Fig. 77), the inside lug has more tendency to break than the outside one, so that if a short lug is used, a smaller amount of leather is broken than if the equal lug were used. Another advantage is: whatever kind of dog is on this motion when a long lug breaks, it can often be used for a short lug, thereby saving supplies. The dog A, is highly recommended. Its value can be seen by a glance at the setting in Fig. 74: fix the dog about $\frac{1}{2}$ inch from the bottom of the arm, or if it is the same as in Fig. 74, fix the extension, which acts as the dog, the same distance up from its extreme throw. Connect the lug strap, leaving a clear space between the sweep stick and the dog; otherwise, when the

dog is pulling in the picking stick the sweep will bind on the dog. Attach the long lug strap, placing it around the picking stick.

When attaching the straps place a large washer between the head of the bolt and the leather, and also between the nut and the leather; these give a better grip on the lug. If the sweep stick is a trifle narrower than the picking stick or dog, it would be best to place a strip of leather between the sweep and the lug before the lugs are bolted to the sweep; otherwise, the picking stick or lug will wear the lugs, which should be avoided. When connecting the lugs, draw out the picking arm to the furthest point, press the picking stick back to the end of the box, and have the lugs and sweep

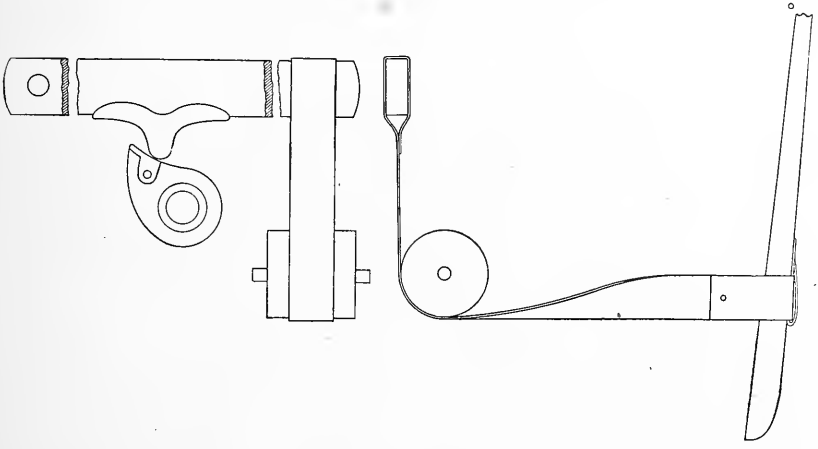


Fig. 80. Canvas Drive Picking Motion.

stick connections about $\frac{3}{4}$ inch longer than is necessary to taken up the space between the stick and the dog. Next attach the stirrup strap to the back of the picking stick, and fix it so that the connections will be level. An extra hole above and below the one that holds the stirrup strap is advisable. Setting the connections in this manner gives the most even pull on the straps when it is most required, and they last longer on account of the greater surface of leather being used. It also allows for a slight change for increasing or diminishing the power without materially altering the square pull on the lugs.

The fixing of these parts on an extreme plan is not advisable, because extreme changes have to be made whenever a change is

necessary. It is sometimes claimed that to fix the lug about 2 inches higher than level on the picking stick, and to have the dog at the bottom of the picking arm, gives good results, but this method does not give as good as with the above setting. In the first place, the pull is exerted near the middle of the stick, and as the shuttle is held in the box by the binder, the stick is being pulled against two pressure points; namely, the shuttle and the fulcrum point at the bottom; and as the leverage has been lost through fixing near the center of the stick, the stick bends somewhat. This means loss of power and has to be overcome by dropping the dog and cone as low as possible. When the lugs are fixed below the center to the extent as they were fixed above, the result is a vibrating stick, owing to the length above the point where the pull is exerted. The stick is often broken by both of the extreme settings, and the edge of the lug straps are cracked more readily.

Some makers of looms fix an adjusting screw to the shoe G[2] This is to give increased elevation to the back of the shuttle when it is leaving the box; but a number of shoes are designed to give a slight elevation without having to adjust any part. They are best when made in this manner. If the shoe is not fitted with an adjusting nut, and there is not sufficient elevation to the shuttle, it can be obtained by inserting a piece of leather between the shoe and stick at the top of the shoe. If, on the other hand, the shuttle is elevated at the back when in the box, but is almost flat when leaving the box (and this occasionally happens), a piece of leather inserted between the tongue and the stick, but at the bottom end, will decrease the elevation at the back, and when leaving the box, increase if the best results are desired, say about $\frac{1}{8}$ inch. This keeps the front end of the shuttle down toward the race plate, and it enters the shed better, on account of the small space there is at this time. Almost invariably the yarn is lower in the shed beyond the temple; the yarn that passes through the temple is also higher up off the race plate than the rest of the yarn; so that if the shuttle were running flat from the box, the front end would be guided up too much by the higher yarn, and when the shuttle reached the lower portion of the shed beyond the temple it would have a tendency to fly out.

The Bat Wing, or Ball and Shoe Pick. There are several

kinds of picking shoes, but while a long sweep shoe is certainly the best, yet it can be carried to such an extreme as to lose its value. Fig. 81, which is a shoe with a gradual incline, finishing with the point almost perpendicular, is far better than the shoe with the

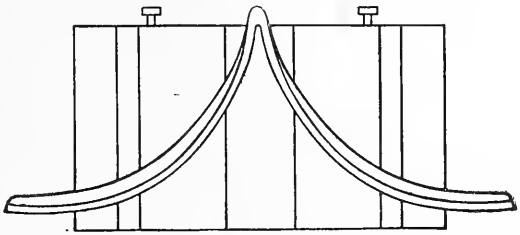


Fig. 81. A Correctly Shaped Shoe.

sliding point, that is, where the ball slides off the top as in ig. 83. This loses the essential feature, the firm finished stroke, because the ball slides off instead of its forcing the shoe; the consequence is power lost. An end view is shown at Fig. 82.

The setting of the pick shaft depends on the shape of the shoe, but the shoe ought to be of such shape as to allow the pick shaft to be set perfectly level. The only case in which one would advocate the raising of the back end of the shaft is when the shoe has a sliding point, as in Fig. 83. This would help the shoe in giving a firm stroke to the finish of the pick, but even then a little of the gradual increase of the speed will be lost, because the ball will strike a little higher up on the shoe. If the shaft were lowered at the back, to take off some of the harshness of the pick caused by the steep incline of the shoe, the result would not only be a sudden sharp pick, but also an uneven movement to the picking stick, caused by the ball striking the lower point of the shoe, passing over a section without touching the shoe, and then coming into contact with the incline; as the shoe is tilted, the ball certainly cannot descend lower than its range. (See Fig. 84.)

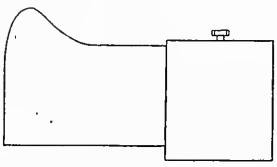


Fig. 82. Reduced End View of Shoe.

The inclining of the shaft also wears out the power or sweep stick quicker than it should be worn, because the stud on the picking arm has not a straight pull on the stick. This tilting some-

times causes the stud of picking arm to break, and frequently the short sharp pick causes both the picking arm and the picking stick to break. There is nothing better than the shoe that enables the shaft to be set perfectly level, for the benefit from the full range of the motion is thus obtained. A glance at the shape of shoes shown in Figs. 81, 83, and 84 will demonstrate this point.

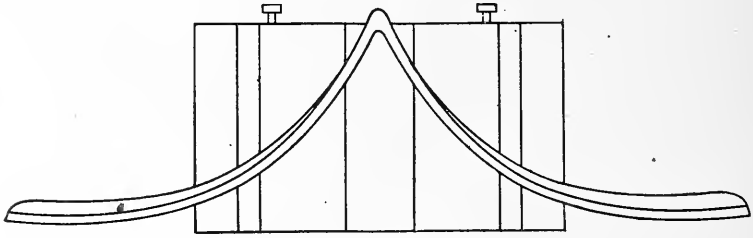


Fig. 83. Old Style Shoe.

The best setting for the shoe shown at A in Fig. 85 is here given. Examine the shoes and see there are no burrs on the inside; that is, on the part that fits on the shaft; it is also well to examine that portion of the picking arm, for the shoe and arm should fit squarely on the shaft, so that when the set screws are tightened, the

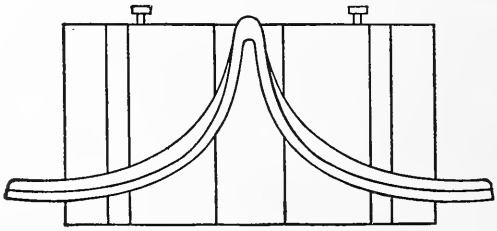


Fig. 84. Shape of Shoe Given an Abrupt Motion.

boss will grip the shaft. If these preliminaries are not attended to the shoes and arms are frequently becoming loose, causing the loom to bang off. Set the shaft B in the brackets, and have the shaft free; i.e., no binding in any part. If using an adjustable picking arm C, as is common on the narrower looms, have the arm at least half an inch below the bracket, so that there is room in which to increase the power if desired, without altering any part of the motion. Set the lug straps on the picking stick in a straight line with the arm. If it is a solid

arm, set the lug straps level with that arm, but be careful not to have the arm too far forward or toward the front of the loom, because when the lay goes back, the stick will bind on the stud and either break the stud or the arm. When the crank shaft is a little over the top center going back, have the sweep stick in a straight line from the picking stick to the arm. Set the shoe so that when glancing down into the loom the top point of the shoe will stand back from the pick cam shaft a quarter to a half an inch. Set the range of the ball D, to meet this, and have the ball sweep up the whole of the shoe. The best possible results are obtained from the above setting.

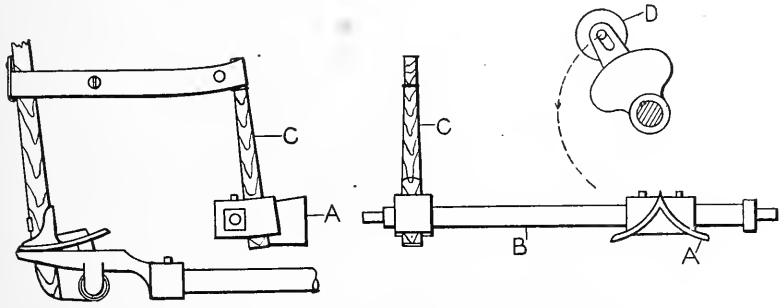


Fig. 85. Bat Wing Picking Motion.

The reason why no rule in regard to the number of inches from back girth to shoe has been given (though some claim it is best) is because no two makes of looms are alike, and to fix the shoe $7\frac{1}{2}$ inches from the socket, would result in having the shoe too far from the range of the ball, or too close to the ball, either case being detrimental to good picking.

Owing to the peculiar shape of the shoe, a stroke is obtained slow at first, but gradually increasing in speed and finishing with firmness. If the shoe is set too far back, the ball strikes on the steepest part of the incline, thus causing a sudden pick, and requiring more power. The fixer often resorts to the lowering of the lug strap on the picking stick which results in a broken picking stick, and a crookedly running shuttle. If the shoe is set too far in, the motion almost locks, producing an uneven jerky pick with loom parts frequently becoming loose and being broken.

The short range of picking stick which some fixers adopt

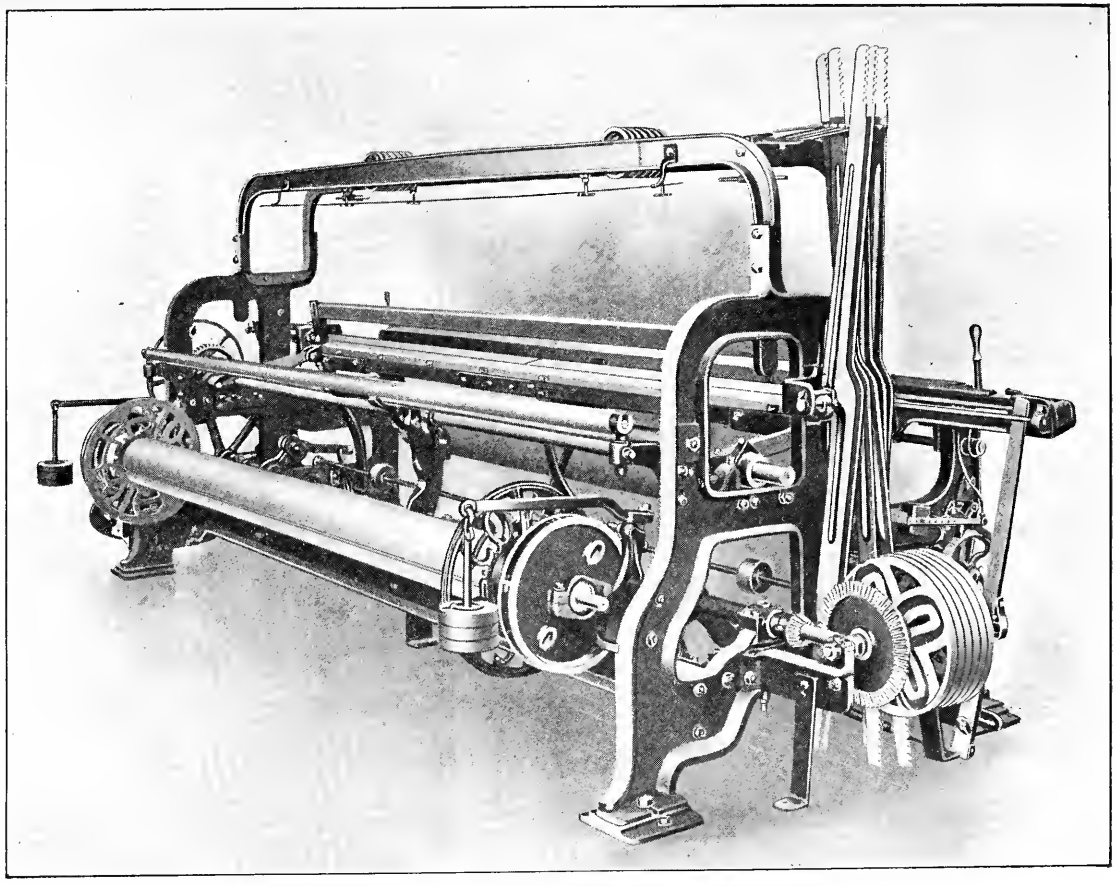
cannot be too strongly condemned; it is faulty fixing, and does not give the best results. Set the ball and shoe as stated, fix the lug strap and sweep stick on a level from picking arm to picking stick, and fasten the stirrup strap on the outside of the picking stick, but not on the front. Next, turn the loom over and try the range, and if there is enough sweep to bring the stick to within 3 inches or 3½ inches of the bunter, the motion is then set to the best advantage.

Study the motion and you will see why the above setting is given, as being the better where a rule is necessary. The shaft you are gauging by is the one to which the ball is attached; consequently that shaft and shoe are relative to each other.

It is well to have a collar at each end of the bottom or pick cam shaft, so as to prevent the shaft from sliding when the pick takes place, because power is lost if the shaft moves in the least. The teeth on the driving gears are worn more where the pick takes place, and where the protector strikes the receiver; so that if fixing up an old loom, it is well to turn the gear around to some other part of the shaft, for by this means the gear lasts almost twice the usual length of time.

For the plain loom, a bunter can be made from a roll of cloth, wound as tightly as possible, then driven into the end of the race; or several pieces of leather nailed together, and placed in the race with the edges facing the picking stick. The picker strikes the bunter instead of the solid portion of the end of the race, which would very soon break both picker and picking sticks.

Saving of Pickers. It is sometimes necessary and always desirable for fixers to devise ways and means to help in saving supplies. The following is a method whereby pickers can be made to last a little longer, besides helping to use up the old pieces. If there are any rawhide pickers used in the mill, take some of the old ones and soften so as to cause that portion which passes around the spindle to become pliable, and allow its being flattened out; it can then be cut to the same shape as a layer of the leather picker. Place this on a portion of the old picker and add a layer of leather to the front; these should be made the same thickness, of course, as a regular picker. A little glue can be added to join the pieces together, and all can be nailed together afterwards. Or



SIDE CAM FLANNEL AND BLANKET LOOM, 110-INCH REED SPACE

Crompton-Thayer Loom Co.

take some scrap leather, choose the firmest pieces, and cut them to the shape of the picker, and add these to the best part of the old one, nailing all together, and you will find that there will be a considerable saving in pickers.

Swells or Binders. The term binder or swell is the name used to designate the loose portion which holds the shuttle in place when in the box. The part which a particular binder plays in the production of a loom, is not taken sufficiently into account, and careful consideration of the following is consequently necessary. There are two distinct shapes; we will term them the bow or blunted swell, and the gradual tapered swell.

Front Binders. The first to be considered, Fig. 86, is a swell that bulges into the box, and actually closes up the space which the shuttle should occupy, and to which it should have almost free

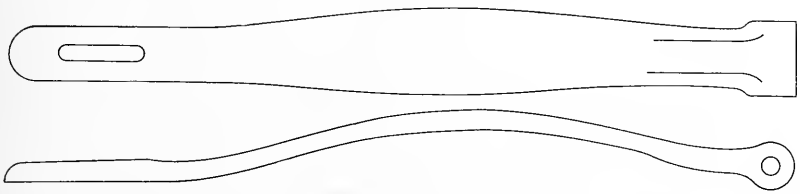


Fig. 86. Blunt Shaped Binder.

access; consequently the shuttle strikes hard against the swell in entering. More power is required to drive the shuttle when this swell is used, because it comes suddenly in contact with a too great resistance. This will in turn cause undue friction on the binder pin, also on the protection finger. There are more rebounding shuttles from the use of blunted swells, than from almost any other source.

There being less space in the box where the shuttle strikes the binder, more power must be applied to the pick motion to drive it far enough into the box. This sudden jar not only checks the shuttle but causes the binder to spring back, when the pressure releasing the shuttle allows it to shoot into the box, with the result that it strikes hard against the picker, forcing the stick against the back end of the box, and finally the hard check thus received makes the shuttle rebound. The loss incurred through a

rebounding shuttle is well known, consisting of, pickers worn out very quickly; filling broken, whether on cop or bobbin; smashes often made by the jumping of the shuttle spindle; poor selvedges caused by slack filling; and the loom frequently banging off and stopping. Moreover, straight or decent looking shuttles are rarely seen on looms that have blunted binders. The face of the shuttle is entirely worn away, thus frequently cutting the filling.

To overcome the faults caused by the swell described, the fixer often sets the picking stick so that it stays in the picker race about three or four inches from the back end of the box. This is a very poor method of remedying the difficulty as shown in the section on fixing the picking stick.

The Gradual Tapered Binder. Fig. 87. This is by far the better, and in order to run shuttles correctly and to keep them in good condition should be used always. The shuttle instead of being jarred when it enters the box, gradually slides in, and by the time it has reached the proper point, it has been gradually checked, the binder in part acting as the check, as it should.

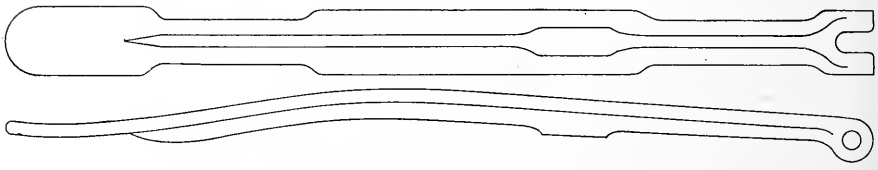


Fig. 87. Gradual Tapered Binder. The Better One.

When using a tapered binder, it is seldom that a patent check is required; all that is necessary is a double piece of leather at the back end of the box. The following should be emphasized: The more suddenly the shuttle is checked as it enters the box, the more liability there is of the filling breaking or being cut; because the shuttle not only strikes the binder and is jarred, but the back portion of the shuttle comes forward and strikes the front entrance of the box. If the lay could be stopped while the shuttle were being thrown from box to box, the blunted swell might possibly be defended, but even then its utility would be small in comparison to the tapered swell. It is not well under any circumstances whatever, to fix a binder so that it checks the shuttle as soon as it enters the box, or in other words, never bend the binder as near

the front end of the box as possible, because it is faulty fixing. There is not a loom in existence which does not bang off at some time, and if it is one where the binder has been fixed in this manner, and a cloth is being woven anywhere near the full reed space, the result will often be a smash, because one end of the shuttle is in the shed while the other end is in contact with the binder, and has pressed it out just enough to clear the dagger from the receiver. This means that the loom will run one or more picks, and that the shuttle will break the yarn. Sometimes by the above method of fixing, the reed will be destroyed, the shuttle chipped, or the filling fork become bent.

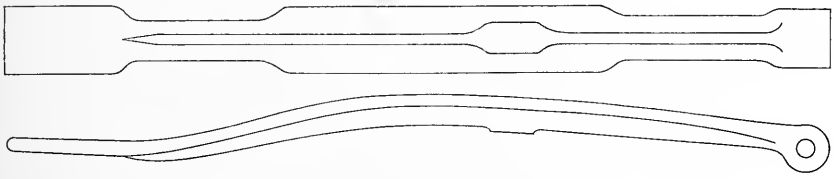


Fig. 88. Tapered Binder.

The following system is undoubtedly preferable and should be followed closely. Taper the binder, that is, have no hard shoulder on it; and when the shuttle is in the box, have the binder grip the shuttle as near the center as possible. This method is better because there is no fear of a smash from the shuttle if it is partly in the shed when the loom bangs off; then there is no jar to the shuttle when it enters the box, and the back end of the shuttle will not strike the front entrance of the box. Fig. 88.

If the binder grips the shuttle toward the front end, from the center mark, you are not only trying to force it out when picking, but you are also pressing unduly against the binder pin, because the greater part of the shuttle is behind the pressure point, with the result that the pin is soon worn, causing the binder to have uneven pressure, besides cutting the filling occasionally. When the binder is fixed so as to grip the shuttle toward the back end almost invariably there is more movement to the front end of the binder, and this means added friction on the dagger and dagger finger, resulting in the dagger finger being worn out quicker than

is necessary. This method of fixing the binder will often cause a crooked running shuttle, because the shuttle leaves the binder too soon, and when the full power is applied to the stick, there is nothing to guide the shuttle, and it wobbles when leaving the box. If adjustable steel binders are used, those that are fixed to a loose part of the front of the box, it is well to bend the back end a little from the shuttle; if this is not done, the end of the swell will sometimes cut the shuttle. There is no need to have the binder in contact with the shuttle for half its length or more, as is practiced by some fixers; one-sixth is all that is necessary because in nine out of ten cases with the former style of fixing, the front end of the binder is pressing against the outside pin, so that there is more movement to the dagger than is necessary, and also undue pressure on the shuttle, which eventually causes the shuttle to be cut at the back by the slot in the boxes.

Back Binder. The question as to whether a front or back binder is the better, has been much disputed. The front binder is undoubtedly preferable, and may be proven in various ways. With the front binder, the protection motion which has a receiving plate or plates under the breast beam is used; the protection fingers are fixed on the protection rod at the front of the lay sole; and these being placed in this manner enable the fixer to make any repairs that may be necessary, and in far less time then when the rod is placed at the back of the lay sole. When the top ends of the two fingers on the front protection rod are pressed against the binder, and both the binders are of the same shape, the dagger point moves in the same direction whichever binder is being operated. This is not always the case with the fingers used for the back binder. Owing to the ends of the rods being bent at right angles from the lay sole, it is possible to have the top ends of the fingers pressed against the binders, and the bottom end of one of the fingers closer to the lay sole than the other. This causes the dagger on one side to be raised higher than the other, and is a source of annoyance, for when the speed changes, the one that is raised the least will occasionally cause the loom to bang off.

A front binder when correctly shaped, presses the shuttle to the back of the box, and when a shuttle is kept in contact with the back of the box, it will most certainly have a better chance

to hug the reed as it passes across the lay from box to box.

A back binder presses the shuttle to the front of the box, and when it is being picked from the box, to come in contact with the reed, it depends upon its own weight and the motion of the lay. There is greater tendency to have a wedge shaped box through the back binder, than by the front binder.

BEATING UP.

The third principle movement in weaving is beating up; that is, the beating up of the last pick of filling after it has been laid in the shed by the shuttle, the constant repetition of which results in the formation of the cloth.

Eccentricity of the Lay. There is a slow and fast movement to the lay, which is absolutely necessary for the formation of good solid cloth. It is the unequal motion which gives the name of beating up to this part of weaving. If the motion were equal, the filling would simply be laid in, consequently the cloth would be open and loose.

The lay travels with greater speed as it comes forward to beat up the last pick; and with less speed when the shuttle is travelling across the lay. The value of the eccentricity of the lay is seen, not only in the firm cloth produced by the quick beat, but also in the longer time it takes the lay to pass beyond a certain point while the shuttle is running from box to box. It would be impossible to pick the shuttle across the lay, and have it clear the shed as it should, if there were not a slowing down of the speed of the lay at this time; unless tremendous power were applied to the pick motion. Even with eccentricity, it is difficult on some looms to get the shuttle clear of the shed. This is mainly owing to the short range of the crank, and the size of the shuttle being too great.

There is a general impression that the slowing down of the lay is caused by the pick motion, but that is not so, although a pick motion that is fixed so as to give a hard blow, will tend to check the lay, but this is the result of faulty fixing.

It would be well if the loom makers would construct the lay swords so that they could be altered to do the best of work on various fabrics; instead of having the lay sword fixed direct to the

rocker shaft have a bracket with slots in it attached to the shaft, and the swords bolted to the bracket. This would admit of the changing over of the loom from fine to coarse goods or heavy fabrics. In manufacturing coarse goods a little larger shuttle should

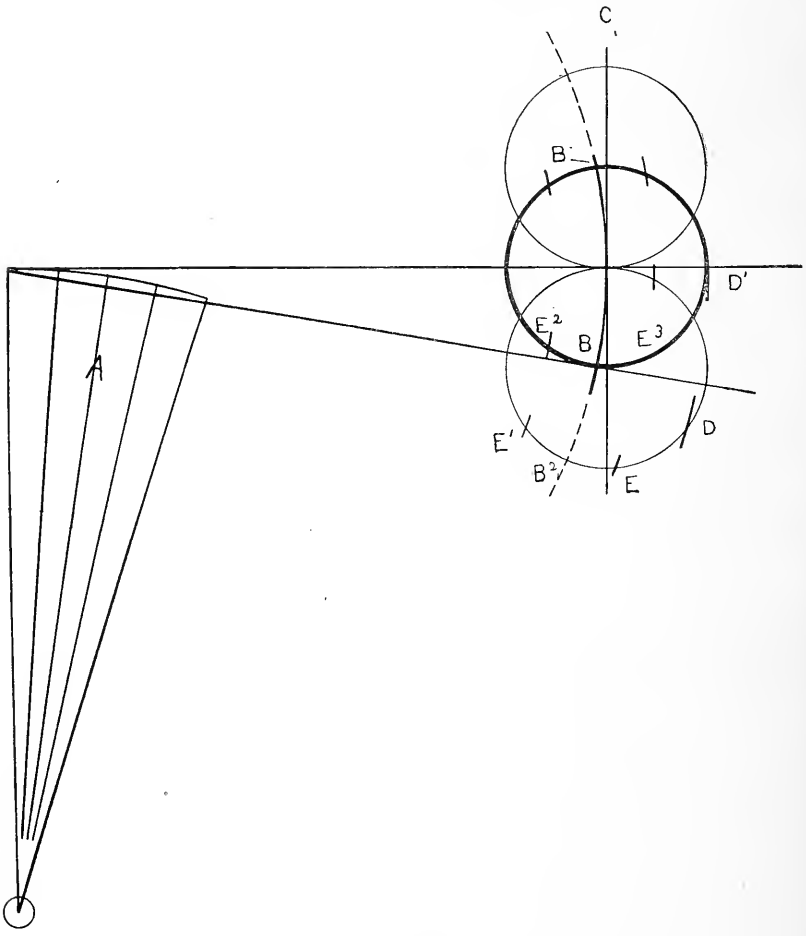


Fig. 89. Diagram Descriptive of Beating Up.

be used, owing to the necessity of having more filling on the bobbin, or a larger cop; in this case a slight increase of eccentricity would allow a slightly longer time for the larger shuttle to pass through the shed, without noticeable increase of power on the pick, also

with less possibility of breaking out the side ends. For coarse or heavy goods a firmer beat up is required to help in the making of the heavier fabric, and nothing would be lost because of a little extra time for the shuttle.

The eccentricity of the lay is caused by the crank shaft being on a higher or lower plane than the connecting pin of the crank arm of the lay. Fig. 89 shows a diagram representing the lay connected to the crank shaft. A sectional view has been made use of, cut through the lay sword and lay sole, with circles to describe the motion of the crank shaft. The heavy circle represents the crank shaft on a level with the connecting pin. The two light circles show the crank shaft, higher or lower than the central point. If a crank has a radius of 3 inches, it will give a movement to the lay of 6 inches; so that if the crank shaft is fixed on the same plane as the connecting pin, whatever position the lay is in when moving back, the crank shaft will be in the same relative position when the lay moves forward. A glance at the diagram will show this. Line A, represents the lay moved half its distance, say backward; describing the arc B, from the center, shows that the crank would be in the same relative position when the lay has gone back to its full extent and has returned to the same half distance again, indicated by B, so that there is equal movement to the lay when the crank shaft is on a plane with the connecting pin. The commonest illustration of this is the crank pin on an engine.

If the crank shaft is dropped to the position shown by the lower circle, it will readily be seen where the crank shaft would be when the lay is moved half its distance, still using the same measurements as at first, so as not to confuse. The dotted arc, B^2, shows the position of the crank when the lay has been brought back to half distance, and the space between the dotted arc and line C, is considerably larger than the space between arc B and line C. D and D^1 indicate where the crank would be when on its back center; D clearly proving the longer length of time that would be allowed for the shuttle to pass across the lay. E shows how much less distance the lay would have to travel to reach the cloth by the lower setting, than by the level setting, indicated at E^3.

American looms are set by the lower setting; English looms by the top setting. The former passes back, the latter comes forward. The greater space from dotted arc to line C, shows that the lay will travel the last portion of its movement in quicker time, and so give a firmer beat to the cloth. The longer path from the beat up to the point occupied by the lay when it has travelled back to its furthest limit means that there is more time to get the shuttle across the lay. This is simply because more time elapses in the passing over of the lay, from the time the pick takes place (top center) to the returning of the lay.

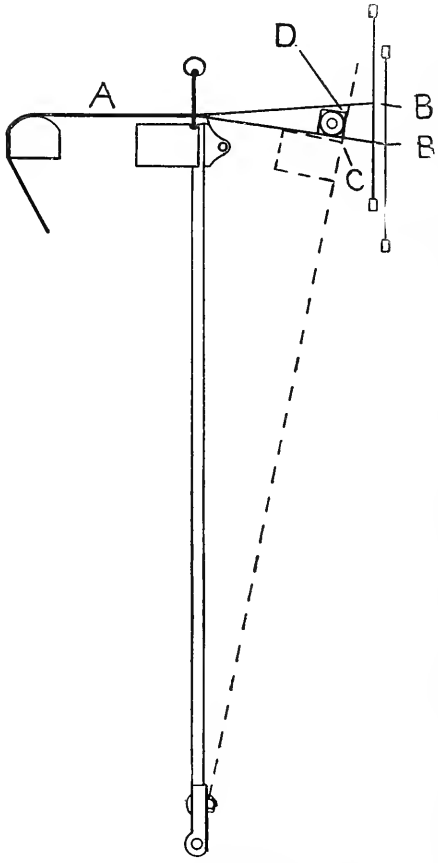


Fig. 90. Perpendicular Lay.

Again, if the lay is a little farther back, (even a very small amount) when the pick commences, there will certainly be more space for the shuttle to enter the shed, which is actually the case on the lower setting. A fixer realizing these points can adjust the motions of a loom so that better results are obtained than if he knew nothing of the values of eccentricity. The eccentricity of a loom is generally determined by the loom fixer; but looms at the present day are very seldom worn out weaving the same class of goods they were intended to weave so that changes being frequently necessary, better results can be obtained where the lay swords are adjustable.

Lay soles, heavier than those in general use, are an advantage as there is more stability and the power of the beat-up is increased.

A race board is preferable to a race plate; it is easier on the yarn, the shuttle travels better, and in general gives better results. It would be an advantage to have the rocker shaft fixed, so that when beating up, the lay would be forward of perpendicular; this would prevent the lay from descending too far, when at the back center, as it does in many looms. A glance at Fig. 90 will show this plainly. The objection to the setting of the lay shown at Fig. 90 is that the shuttle to run straight ought to lie flat on the yarn on the race and hug the reed; but it cannot do this because the yarn tilts the shuttle up, and in the endeavor to overcome this, the harnesses are lowered to get the yarn on the race. By this arrangement it is then so low on the front edge of the race that it rests there for over three quarters of the movement of the lay, which is most certainly detrimental, as the yarn is constantly chafed. Line A, shows position of warp yarn when the lay is beating up the filling. B B shows an open shed, with lay on back center; C shows how the bottom shed would be above the back of race plate, and yet on the front edge. D shows the shuttle away from the reed. If the yarn for the lower shed C, were dropped any lower, it would rest heavily on the front edge and would be chafed almost continually while weaving. A remedy for this, is the packing forward of the lay, that is, provided the rocker shaft cannot be changed. Insert a strip of leather, piece of wood or pasteboard, between the crank pin bracket and the lay sword, thus throwing the lay forward.

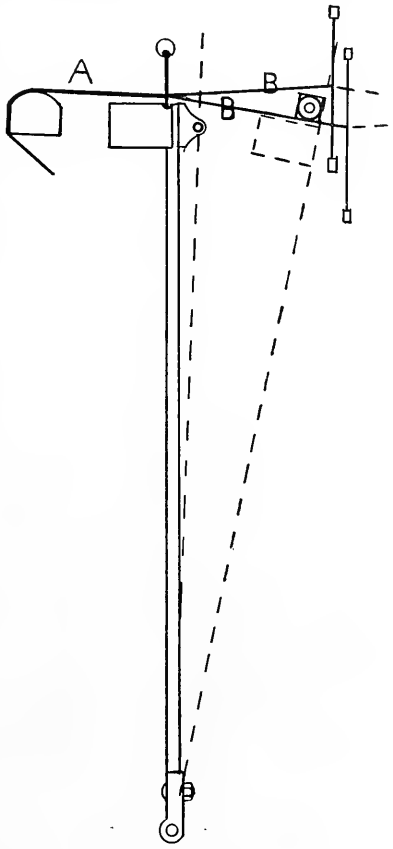


Fig. 91. Lay Forward of Perpendicular.

The Lay. The following parts comprise the lay: Fig. 92, AA, lay sole, a long piece of wood varying in size, according to

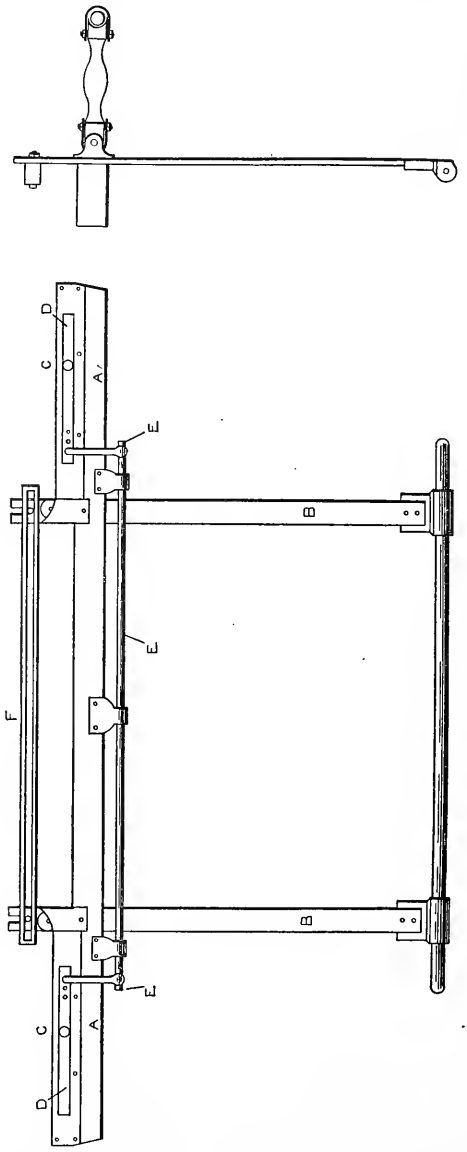


Fig. 92. The Lay and its Parts.

the width and make of loom; it is most commonly made from well seasoned ash. BB, two lay swords which support the sole;

the swords are connected at the foot to the rocker shaft, the crank arms are also connected to a lug or bracket fixed at the back of the swords and lay sole. CC, shuttle boxes; these are placed one at each end but on the top of the lay sole, and vary in length according to the make and width of the loom. DD, swells or binders which are connected to the shuttle boxes; these are explained in a separate chapter. EEE, protection rod and finger. F, reed or lay cap; a groove is made behind the race and in the lay sole, and when the reed is placed in the groove, the lay cap is placed on the top of the reed, then a bolt attaches the cap to the tops of the lay swords.

Shuttle Boxes and Shuttles. Shuttle boxes should be made with sufficient room for the shuttle; this is becoming more widely recognized than formerly. There are shuttle boxes on some looms with not a half inch to spare; that is, the shuttle is of practically the same length as the box, which is anything but correct, for if the shuttle does not reach the end of the box when picked over, the loom is likely to bang off. This will frequently happen, especially if the speed varies. The pickers are worn out sooner on such looms, because the shuttle bangs hard against them. These looms often make smashes, part of the shuttle being in the shed, while the rest of it is far enough in the box to press back the swell and so lift up the dagger. Almost invariably these looms have a blunt swell, and the whole construction is a source of endless trouble; less floor space and a slight lessening of the weight of the lay, is the reason claimed for their use. This gain, however, does not half make up for the loss entailed by their operation. As stated in the chapters on picking; the box should be one-quarter of an inch greater in width and height than the shuttle. There should be at least two inches to spare in the length of the box, and three would be better. The explanations concerning swells should be brought to mind in connection with this.

Shuttles vary in length from $12\frac{1}{2}$ inches to 18 inches, though some are longer than these. The commonest size for narrow looms weaving from 28 to 36 in. cloth, is one that is 13 to $13\frac{1}{2}$ inches in length, $1\frac{1}{2}$ inches in width and $1\frac{1}{4}$ in depth; this is for weaving cop filling. Shuttles for weaving cop filling can be smaller in width and depth, than when weaving filling from the bobbin.

In Fig. 93, A, E, F, show the shape of three excellent shuttles. A is a small shuttle for cop filling; E a combination cop and bobbin shuttle; F is also a bobbin shuttle; all three of these entering the shed in as near a perfect manner as possible. When run correctly, they will not spoil the selvedge threads. C and D are large woolen loom shuttles. D is the better of the two and is fitted

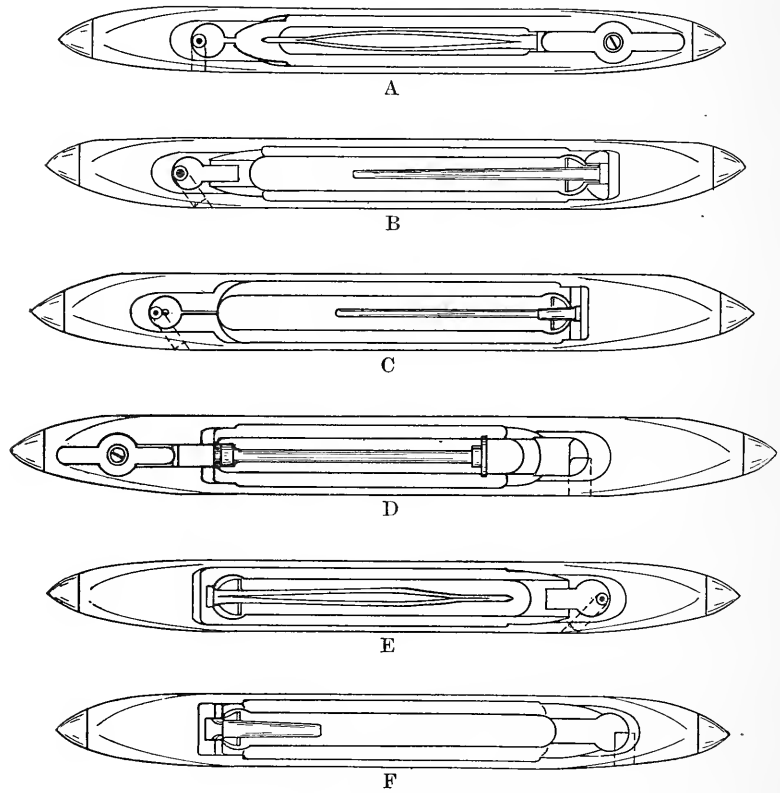


Fig. 93. Different Types of Shuttle.

with a patent spindle in order that it may carry twister bobbins. There is no need of a long backed shuttle, B and C; it is a fallacy to think that the long back helps it to hug the reed; on the other hand, this shape has a shoulder that very often spoils selvedges, breaks out selvedge threads, beside requiring more power to drive the whole across the lay. A tapered shuttle is far better, and the

points to be considered in ordering, should be to have as much taper as possible, and with the tip in the center.

This style of shuttle requires less power to drive it, as it meets with less resistance in its passage out of one box and into the other. When the pick commences, the crank shaft is on the top center; there is then but very little space for the shuttle to enter the shed. Of course, as the lay travels back the space is increased, but the shuttle is travelling at the same time, and when the full space is realized the shuttle is two-thirds across the lay, for by the time the crank shaft is between back and bottom centers, the shuttle ought to be full in the box. Hence the reason why a tapered shuttle is better; a longer time elapses before the large part of the shuttle reaches the shed; the lay is travelling back, and there is consequently less resistance; it runs better also with less power, and the liability of its being turned over is not as great. As proof of the latter, it is a well-known fact that a shuttle picked a trifle early, will sometimes be turned when it reaches the opposite box; it is also thrown out occasionally. If a little earlier picking will cause the above faults, there must be a gain from increase of time. Do not mistake this by thinking that the faults could be overcome by later picking; the shuttle would not be clear of the opposite end of the shed and more power would have to be applied to get clear of it.

LET-OFF MOTIONS

The meaning of the term "let-off" is the allowing of the requisite quantity of yarn to pass off the beam, in accordance with the taking up of the woven cloth.

Gear Let-Off. Fig. 94 shows a sketch of one style of gear let-off. There are many styles, all of which require fine adjustment if good results are desired. The different styles vary somewhat in construction, but all are controlled more or less by the vibrations of the whip roll. Some in addition to this are assisted by the lay sword. This figure is one after that order.

Fig. 95 is a let-off which shows a combination of gear and friction. Another style is arranged in the following manner: An arm descends from the whip-roll, the lower end of the arm being in contact with a sliding beveled gear. This gear is connected

to a small shaft by a loose key, so that the gear can turn the shaft yet slide freely on it when pressed forward by the whip roll arm. A second beveled gear is fixed on the bottom shaft. The shaft that supports the sliding gear has a worm fixed on its end. This worm is geared into a worm gear fixed on the arbor of the beam.

When the lay beats up, the warp is tightened and in this way the whip roll is caused to oscillate; the whip roll arm then forces the sliding gear pulley against the fixed gear. This gives motion to the sliding gear, which through the turning of the worm and the worm gear, causes the warp to let off more or less yarn. This is

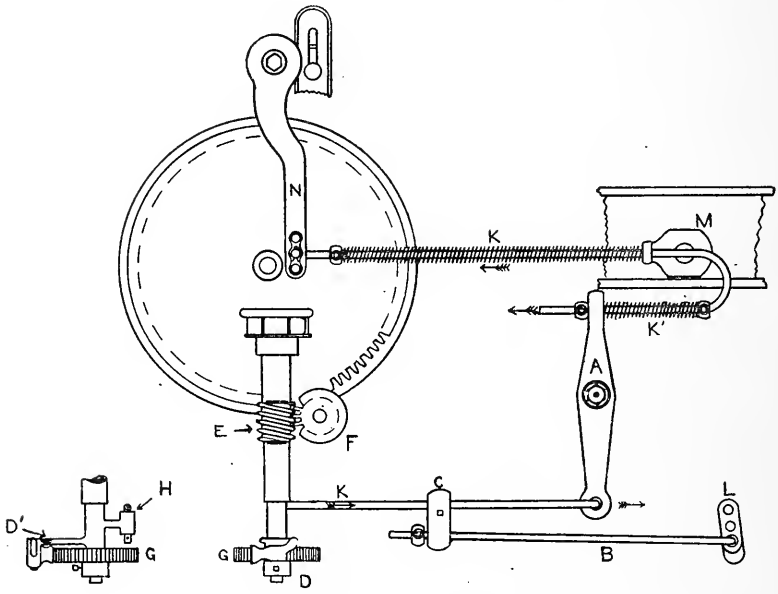


Fig. 94. Gear Let-Off.

considered a very good motion. The length of yarn let off varies according to the oscillation of the whip roll, because the friction pulley will come in contact with the fast pulley earlier, and will also remain longer in contact.

It is not always best to give much motion to the whip roll, especially if very thin cloths are being woven, and this let-off being used, the extreme oscillation is likely to cause thin places, by allowing too much movement of the yarn. (Note causes of

uneven cloth.) Fig. 94 shows very clearly the whole motion; the upper spring K, is the one which is changed to obtain the different tensions on the warp, by loosening the small set collar and compressing the spring. In this way more tension is added to the warp, while the opposite will reduce the tension.

With this motion it is best to have the upright lever A, almost perpendicular when the lay sword is drawing forward the rod B, so that on the extreme front the upright lever will have

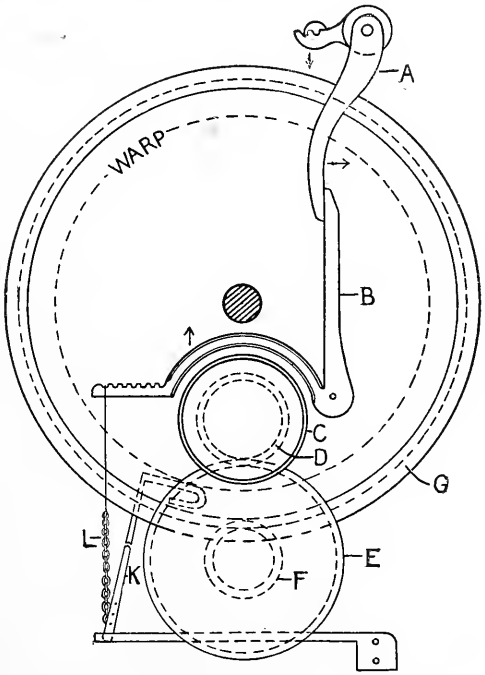


Fig. 95. Friction and Gear Let-Off.

moved an equal distance to the opposite side. The compression on the lower short spring K^1, (which counterbalances the oscillation of the whip roll and the rebound of the top spring) is governed by the stoutness of the top spring. The diagram gives a very good position, having been used on a loom weaving a 5 end satin cloth with about 180 picks per inch.

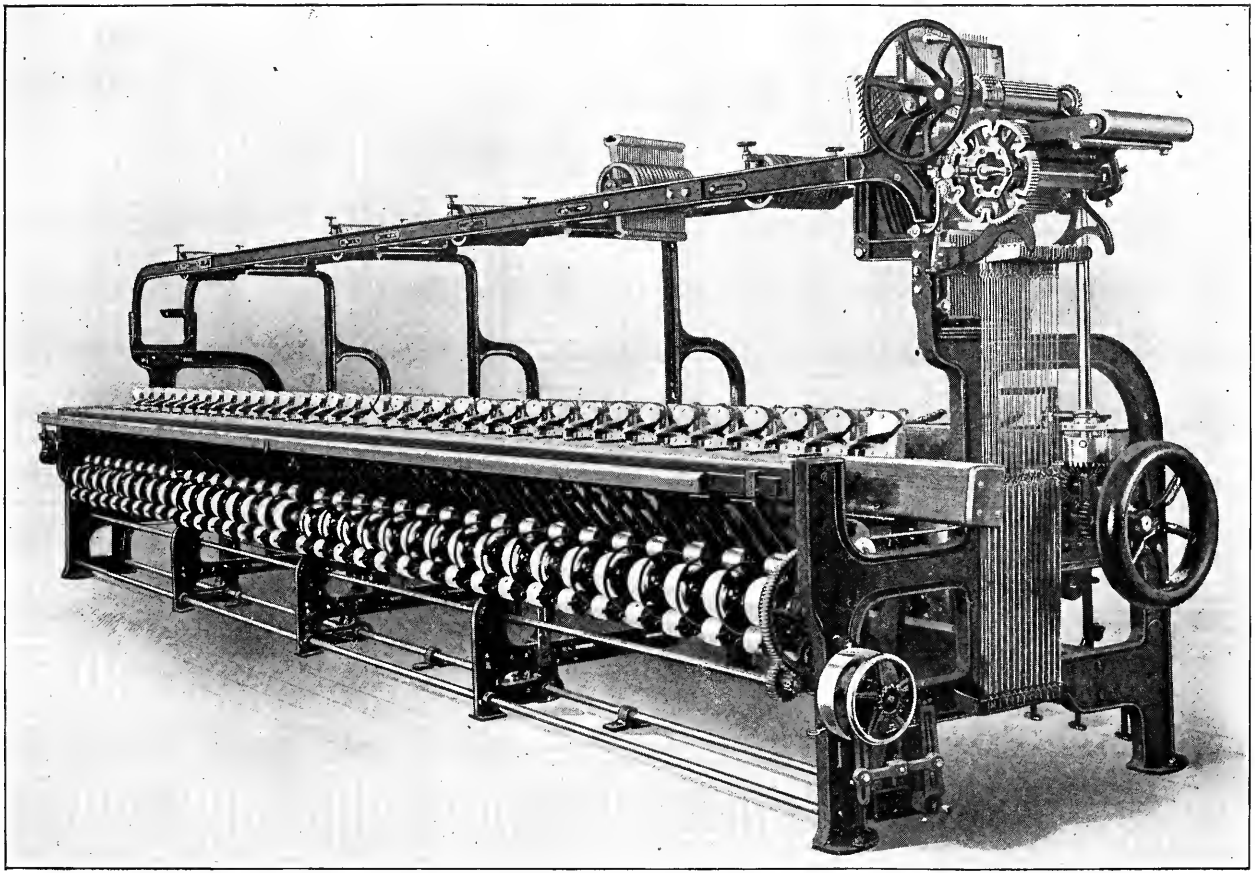
This is sometimes called a positive let-off motion, but inasmuch as the pawl D, will cover two or three teeth at different

times, it is scarcely positive. When setting this motion be careful to see that the gears are not too deep, for often the bottom of the teeth on the beam head are rough, and the rough places cause the beam to jump, with the result that there are thick and thin places in the cloth. The worm E, ought to be set in the gear F, so that the shaft with the worm and ratchet gear G, will turn freely by hand. The stud on the oscillating lever H ought to be in good condition; on this stud the rod K is placed; so that if the stud is worn, there is uneven motion to the lever, and consequently the pawl D, will not turn the ratchet as it should. The pawl is attached to lever D′, and the point of the pawl is held in contact with the teeth of the ratchet by a small spring at the back end of the pawl. Sometimes the small spring loses its power and the pawl does not engage in the teeth of the ratchet; the edge of the pawl becomes worn, and if either of these take place the result is uneven cloth.

Sometimes the spring that is in the hub of lever A, loses its power owing to the weaver not keeping the lever clean, or by undue pressure on the lever; the result is uneven cloth. Occasionally the bracket M, will be displaced; this causes the motion to bind; or if during cleaning, the upright shaft E, is displaced, the results will be very poor cloth.

These motions require great care, for if any part of the motion be out of place, or worn too much, the result will be a great variation in the picks per inch and consequently a cloth that will be rejected. Through failure to attend to these motions, cloth has been woven with a variation of 8 to 12 picks per inch more, or less then there should have been.

Motions such as Fig. 94 should be changed as the warp decreases, that is the tension spring should give less tension, because a smaller warp requires less weight or tension, but Fig. 95, shows a motion designed to control itself. A is the whip roll arm, the lower portion of which is in contact with the friction lever; the friction lever rests on the pulley C; on the same shaft as C is a small spur gear, which meshes into the larger gear E. E is a small shaft which runs parallel to the back brace of the loom; on the inside end of this shaft is the gear F; this gear meshes into the teeth of the beam head G. An extended arm H,



RIBBON LOOM FOR WEAVING ELASTIC AND NON-ELASTIC WEBBING

Crompton & Knowles Loom Works

is fixed to the lower portion of the loom; to the end of this arm a strip of iron is fixed $\frac{1}{2}$ inch by $\frac{1}{8}$ inch, and 18 inches long. K shows the shape of this strip. The bend of the strip is held in contact with the yarn on the beam by means of the spring L; this spring is connected to the friction lever. The larger the beam the more the spring is stretched; this will cause the friction lever to rest more heavily on the friction pulley. The less the amount of warp the higher the strip is, and the less stretch to the spring, with less pressure of the lever on the pulley. The motion is operated by the vibrations of the whip roll. As the lay beats up the whip roll descends, giving movement to the whip roll arm,

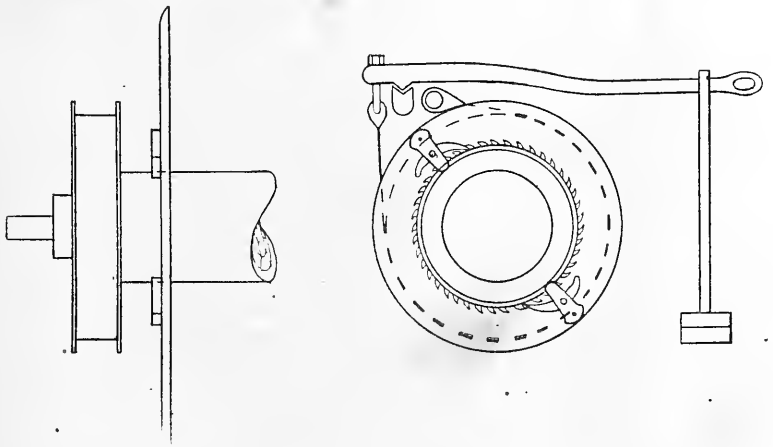


Fig. 96. Friction Let-Off. Woolen Loom.

causing the friction lever to be raised up from the pulley; arrows indicate the movement. The greater the motion to the whip roll the higher the friction lever is raised, and more yarn is let off from the beam. It is the strain on the yarn by the beating in of the picks of filling, together with the taking up of this yarn, that causes the motion to be let off the warp, when the friction lever is raised.

This motion is also designed to be a smash preventer, in addition to a let-off. If the shuttle by accident stops in the shed and the protection is out of order, when the reed comes in contact with the shuttle more motion is given to the whip roll, and the

friction lever is lifted entirely off the pulley; there being no tension on the warp it slackens off and so prevents a smash.

There are various opinions in regard to the value of the several let off motions, subject however, to the statement that no motion whether friction or gear, will yield good results if not kept in good condition.

Friction. There are several ways of obtaining friction for

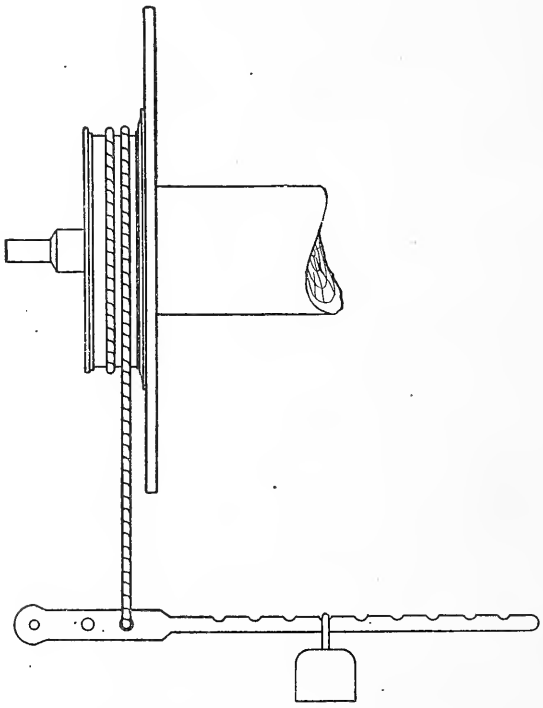


Fig. 97. Rope Friction Let-Off.

the friction let-off, but the use of rope is the most common. Hemp rope seems to meet the conditions better than anything else; it is less likely to stick on the beam flange and gives an even tension. Chains are used, but they require great care besides the use of a large quantity of black lead, or the chain will groove the flange in a very short time. A steel band is very good, but to obtain the best results a strip of burlap should be placed

around the flange underneath the steel band Fig. 96, A. The knot by which the burlap is tied, ought to be between the connections of the ends of the steel band and not under the band; want of care in this respect will cause uneven cloth.

Raw hide is sometimes used, but is expensive, and becomes hard very quickly, retaining the hoop shape from being around the flange, so that when changing warps care has to be exercised in changing the band, or it will break. With the exception of the heavy looms, (generally for woolen and worsted), a rope friction is undoubtedly better, Fig. 97; it is the least costly, very easily handled, and will serve for thin as well as for thick or heavy fabrics. Very few ordinary gear let offs will do this, as they are able generally, to control only medium weights. The weight required for tension on a warp can only be determined by the weight of the warp, and the picks that are being placed in the cloth, few picks requiring little weight, a larger number of picks more weight. If a friction let-off is used, it must be kept clean, and so far as possible, oil should not be allowed to drop on the beam flange, for if it gets on the friction, it makes it sticky and during the slightest change of the atmosphere, will become uneven in its operation and cause poor cloth.

Black lead should be used in connection with the friction. French chalk is sometimes applied, but it has a tendency to attract moisture. If troubled with the friction sticking, clean it thoroughly and apply a quantity of black lead, also rub the flange with the same.

TAKE-UP MOTIONS.

The take up draws down the cloth as it is woven and winds it upon a roll. If the motion is in good order, the positive take up will draw down the cloth in an even manner, without any other assistance. If a certain number of picks per inch are required in the cloth, a change gear of a certain number of teeth placed in the train of gears will continually yield the same number of picks per inch.

Positive. Positive take-up motions are divided into two classes, Intermittent and Continuous. The intermittent motion is one in which the gear receives motion from a pawl, with which there is an interval between the drawing over of one tooth to the

taking up of the other. These are the most common take-up motions. These motions take up with the motion of the lay, or a cam fixed to the crank or pick cam shafts.

The continuous motion has a worm drive, so that when the

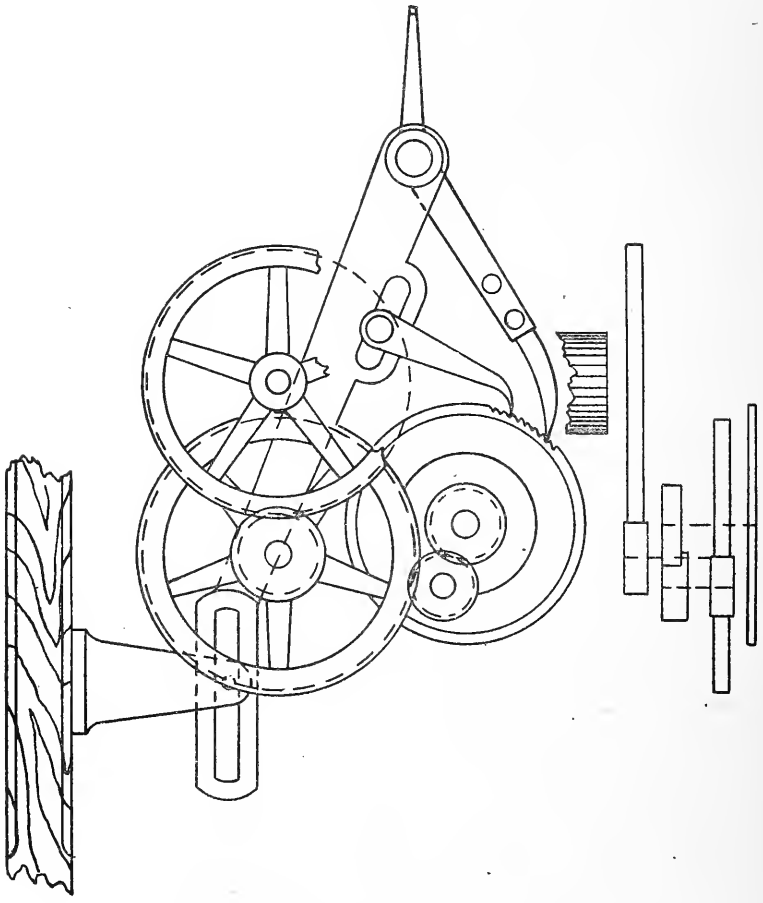


Fig. 98. Take-Up Driven by Lay Sword.

loom is in motion there is constant movement of the take-up. One great advantage of this motion is that if the loom should be run in the opposite direction, the cloth is turned back at the same time, because the driving motion is reversed. This prevents the many thin places that occur with the intermittent motion.

Intermittent. The simplest form of take-up motion in use at the present time, is one that has only three gears. A ratchet, small pinion (which is also the change gear), and the beam gear. With such a motion, there is not a wide range for the changing of the number of picks per inch, so that these motions are generally used in the weaving of coarse goods.

The most common range or train of gears is such as shown in Fig. 98. This motion allows a very wide range for changing, but when, as sometimes happens, an order necessitates a half pick increase per inch, additional gears must be added; so that instead of five gears, there would be seven; or a change would be made in the stud gears.

Fig. 99 shows the ratchet receiving motion from a draw

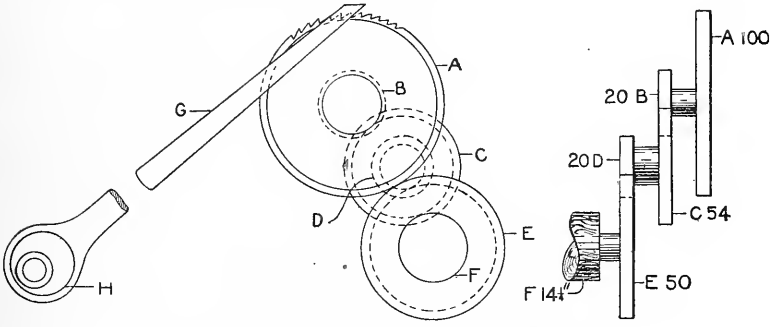


Fig. 99. Intermittent Take-Up Motion.

lever commonly called the take-up lever. This lever receives motion from a cam fixed on the pick-cam shaft. Sometimes the cam is on the crank shaft. On other looms the motion as in Fig. 98, is imparted by the lay sword. Whatever kind of motion is used, it is best, so far as possible, to set the pawls so that they will turn the ratchet while the harnesses are level, or nearly so, because at this time there is the least strain on the yarn, and it requires less power to turn the gears. There is also less possibility with this setting for the pawls to slip over the teeth of the ratchet, owing to the small amount of strain on the yarn. The correct time to set the cam H, is to have the throw of the cam at the front center, when the crank shaft is between the bottom and front centers, but slightly inclined to the front, with the shuttle

in the box at the fork side; setting the cam on this time, allows the check pawl to be lifted freely, to prevent the take up of the gears when the filling breaks, and this also prevents thin places.

If the motion comes from the lay sword, and a draw pawl is used, better results are often obtained by changing to a drive pawl, because the latter will operate the take up while there is the least strain on the shed, and although the shed may be opening as the lay goes forward, the beating up taking place at the same time, weaving the cloth loosely; this point helps in the take up. When the motion however, commences after the lay has beaten up, there is nothing to relieve the strain on the yarn; this causes the motion to work hard, and it very soon wears out.

In the diagram of this motion Fig. 99, A, is the ratchet gear; B, small pinion; C, change gear; D, Stud gear; F, sand or tin roller; G, take-up lever; H, take-up cam; K, crank shaft gear; L, cam shaft gear.

Calculation. To find the number of picks given by a train of gears: Multiply the drivers together, and the drivens together, then divide the greater by the smaller, and the result, with $1\frac{3}{4}\%$ added for take up or shrinkage of the cloth on the cloth roller, will be the number of picks per inch. When only the train of gears that comprise the take up motion are considered in the calculation, the result must be multiplied by two; that is, if motion is received from the bottom or pick cam shaft, but if the driving gears on the crank and pick cam shafts are in calculation, the quotient obtained will be the desired result.

$$\frac{\overset{A}{100}\times\overset{C}{26}\times\overset{E}{50}\times\overset{L}{64}}{\underset{B}{17}\times\underset{D}{21}\times\underset{F}{14.25''}\times\underset{K}{32}}=51.1 \text{ Picks per inch.}$$

$$\frac{100\times 26\times 50}{17\times 21\times 14.25''}=25.55$$

$$\begin{array}{rl} & 2 \\ \hline & 51.10 \\ & .89 \quad 1\frac{3}{4}\% \text{ of take up.} \\ \hline & 51.99 \quad \text{practically 52 picks.} \end{array}$$

$$\begin{array}{rl} & 51.1 \\ & .8 \text{ amount of take-up} \\ \hline & 51.9 \text{ practically 52 picks.} \end{array}$$

When the motion is received from the lay, or the take up cam is fixed on the crank shaft, the result without being multiplied by two will be the number of picks per inch.

Most of the makers of looms, arrange the train of gears so that the change gear gives twice the number of picks as there are

teeth in the gear, namely: a 40 gear will give 80 picks; 45 — 90, and so on. The above train is one of that order. On some makes of looms, the ratchet gear is the change gear, and the number of teeth determine the number of picks; a 60 ratchet giving 60 picks. Whether the train is arranged as above or not, it is best to have a constant number; that is, a number, when multiplied or divided, will give the picks or change gear required. To obtain the constant, proceed as in the first calculation, leaving off the change gear.

$$\frac{A \times x \times E}{B \times D \times F} = \text{Constant } 2{,}000 \text{ or } 2$$

Change gear × Constant = Picks.
Picks ÷ " = Change.

$$\frac{A \times x \times E}{B \times D \times F} = .983$$

$$\underline{2}$$

$$1.966$$

$$.034 \text{ amount of take-up}$$

$$2.000$$

Does the constant obtained agree with the principle carried out in the first calculation? Proof.

We have a 26 change gear. $26 \times 2 = 52$ Picks. $52 \div 2 = 26$ gear.

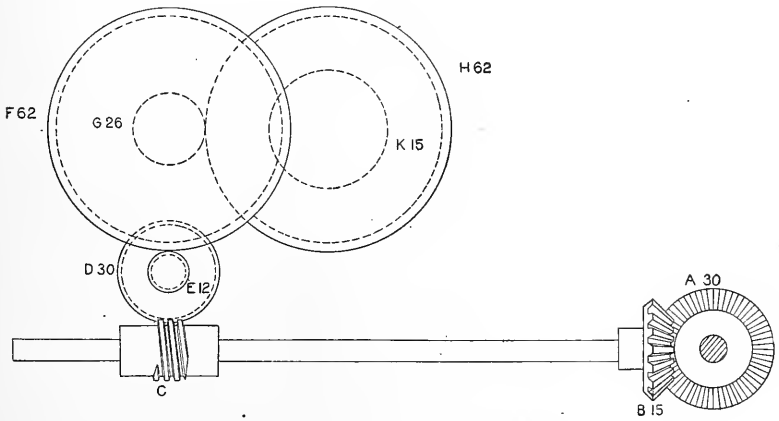


Fig. 100. Continuous Take-Up Motion.

Continuous. Fig. 100 shows a continuous take up motion. A is a bevelled gear fixed on the bottom shaft, imparting motion to a second bevelled gear B. On the same shaft as B, is a single worm C. This is geared into a worm gear D; and through the

open gears E, F, G, H, motion is imparted to the cloth roll K. On some looms there are more intermediate gears added, so as to carry motion up to two or more fluted rollers that are placed under or above the breast beam; but whatever is added, it is simply a continuation of the motion shown on Fig. 100. A worm, is a spiral thread gear, and resembles a spiral ridge cut around a shaft. A worm gear, is almost like a spur gear, or what is commonly called an ordinary gear; but the teeth are set slightly on an angle, so as to mesh more perfectly in the worm. A single worm means, one spiral thread, readily determined by one starting point. A double worm means two spiral threads, determined by two starting points, one from each side of the shaft.

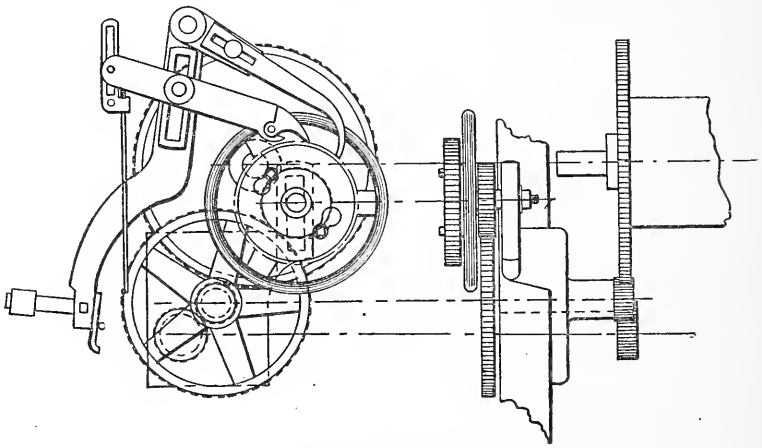


Fig. 101. Negative Take-Up Motion.

When calculating the speed of a train of gears, which receives motion from a worm, the worm is reckoned as one, that is a one tooth gear. A double worm would be counted as two.

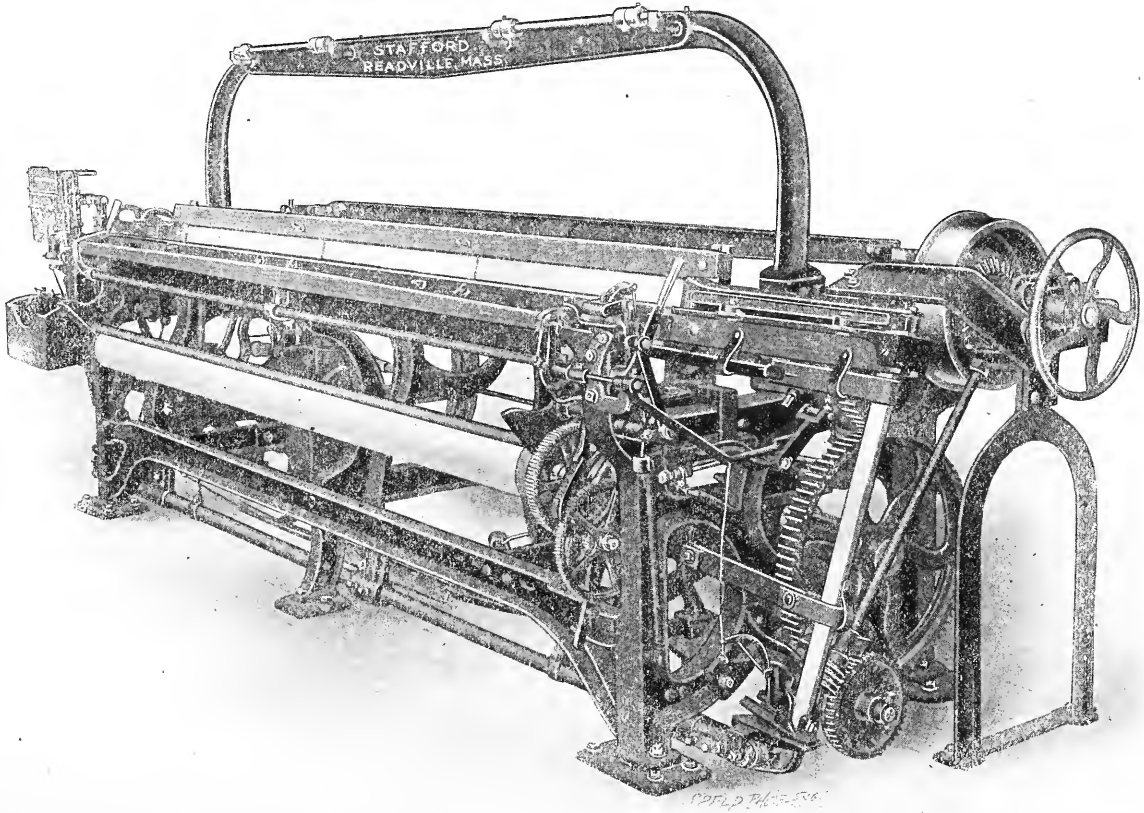
Example.

$$\frac{15 \times 30 \times 62 \times 62}{30 \times 1 \times 12 \times 26 \times 15''} = 12 \times 2 = 24 \text{ Picks.}$$

E is the change gear; one tooth on this gear being equal to two picks; so that for 30 picks a gear with 15 teeth would be used.

Negative. The negative motion is controlled by weight; the tighter the warp, the more picks there are placed in the cloth. A

weight is placed on an extended lever connected to the driving pawl, and the picks of filling are beaten into the cloth by the reed; the cloth becomes loose, causing less resistance to the weight lever, and as the weight gradually falls, the pawl drives forward the ratchet gear, and so takes up the cloth. On high grade goods that have a large number of picks per inch, also on silk looms, it is customary to have a number of check pawls of different lengths, so that with the least move of the driving pawl, a check pawl will engage in the teeth of the ratchet. The motion is generally used when uneven filling is being woven; also on woolen cloths that are woven in looms with single boxes. When more weight is placed on the lever of the take up pawl, the cloth will be taken up faster. The weights on this lever, should be carefully watched and adjusted as the warp decreases in size. Fig. 101 shows a negative take up. This can be used as a positive motion by adding a small casting, indicated by the dotted lines.



BROAD AUTOMATIC LOOM FOR PLAIN GOODS

The Geo. W. Stafford Co.

WEAVING

PART II.

THE FILLING STOP MOTION.

The *filling stop motion* is one of the most sensitive minor parts of a loom and its adjustment requires skill and thought if the best results are to be obtained. There are two distinct forms of filling stop motions both of which serve the same purpose, *i. e.*, cause the loom to stop if the filling breaks or runs out. Of these the alternate stop motion, which is used most commonly on cotton looms, will be described first. It is attached to the breast beam, on the end nearest the driving pulley, at such a point as to cause the fork to pass directly in front of the shuttle-box entrance as the lay swings forward, and is actuated only when the lay is swinging back from the front center just as the shuttle is about to be picked from that side. This action takes place of course only on alternate picks hence the derivation of the name.

The motion in detail, as shown in Fig. 102, consists of the following pieces. An elbow lever composed of two sections, the hammer or upper section, C, and the lower section, B, which are bolted together and hung on the stud at C′. A cam, D, which is fixed on the pick cam shaft to actuate the lever. A grate, F, which is inserted in the lay near the entrance of the shuttle-box. A fork, E, provided with a hook at one end and usually three prongs at the other. The fork is mounted on the fork-slide, G, which slides in the slide-plate attached to the breast beam, often being recessed as shown to admit the end of the shipper-lever.

The action of the motion is as follows: As the cam revolves it raises the lower end of the elbow lever, thus throwing back the hammer, and as the lay swings forward at the same time, the fork enters the grate as shown at K, allowing the hook of the fork to rest behind the hammer which catches as it moves back, drawing the slide with it, and through the shipper lever releasing the shipper

handle, thus stopping the loom. When there is filling across the face of the grate the fork is prevented from passing through the grate, being tipped up instead as shown at L, thus lifting the hook out of the way of the hammer and preventing any action from taking place. Consequently as long as the filling is across the grate the loom continues to run. There are two distinct forms in which the prongs of the fork may be bent as shown at M and N. Sometimes an intermediate form is adopted and in extreme cases the prongs extend further than at N; but for ordinary work this would be defective fixing. The form shown at M is by far the best for

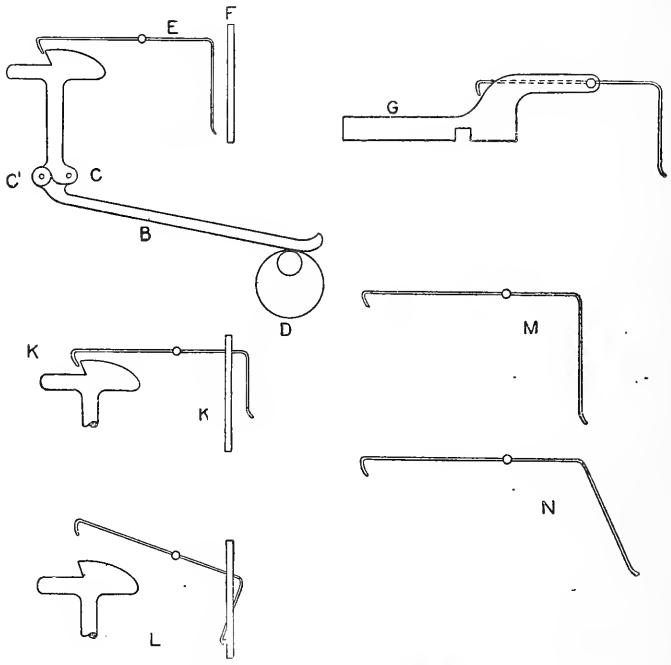


Fig. 102. Filling Stop Motion.

any kind of work. In setting the stop motion several facts must be considered as governing its most efficient action. As strain tends to weaken the filling the fork should be set so as not to cause excessive strain. The less movement required for the fork, the better. Correct timing is absolutely essential.

The prongs of the fork should be long enough to reach below

the level of the race-plate, which is grooved at the required point. If they are not sufficiently long there is a tendency for the filling to slip under them, thus allowing the hook to catch and the loom to be stopped. Also as the lay swings back the filling which was pressed partially through the grate, becomes slack and often curls around the prongs if they are too short. This sometimes causes the loom to stop, but more often the loop so made, weaving down, holds the fork tipped up and prevents it from stopping when it should, until it is broken away. Occasionally this loop is woven into the cloth making a thick place which, especially on fine goods, is a defect. With the fork shaped as at M, the amount of strain to which the filling is subjected, and the amount of movement required, are both reduced to a minimum. When the prongs are vertical or nearly so it is not necessary to have them pass through the grate to the same extent as required with a fork shaped as at N, to produce the same amount of movement.

A glance only is necessary to see that there is less tendency for the filling to slide up on a fork shaped like M than on a fork shaped like N, and it is when the filling presses against the prongs nearest the ends that it is subjected to the least strain. It is especially on a multiple box loom that the effect of straining the yarn becomes most apparent, because on such a loom the eyelet would be in the back end of the shuttle-box as the fork enters the grate, and in the majority of cases the filling would be held tightly between the shuttle and the binder so that no let-off is possible from the bobbin. This being so it may readily be seen that the greater the distance the fork passes through the grate, the more the filling will be strained, often to the point of breaking out. Excessive movement of the fork is always to be avoided, because under such conditions it often rebounds just in time to catch and stop the loom. When setting the motion the prongs should project through the grate not more than one-quarter of an inch, and as some forks are made with short prongs and a long hook, care must be used to make sure that the grate does not come in contact with the slide. If the grate should strike the slide when the lay swings forward, the slide will be pushed back and the loom stopped without any extra jar to which the loom may be subjected.

To time the stop motion it is common practice to push the slide

as far forward as it will go and set the fork and cam to this position. But occasionally the slide slips back from its position when the pressure is removed, reducing the distance which the fork projects through the grate with the result that occasionally the loom will stop, and the fixer having set the motion will naturally think something else the cause of the trouble. With the fork fixed in its correct position, swing forward the lay, and as it is just leaving the front center set the cam to move the elbow lever with the catch of the lever just passing the fork. If at this time the hook of the fork barely clears the hammer, the timing will almost invariably be correct when the loom is running.

There are different shapes of cams used, but an eccentric cam gives the best results. By its use the lever acquires even motion where other shapes cause sudden and uneven motion.

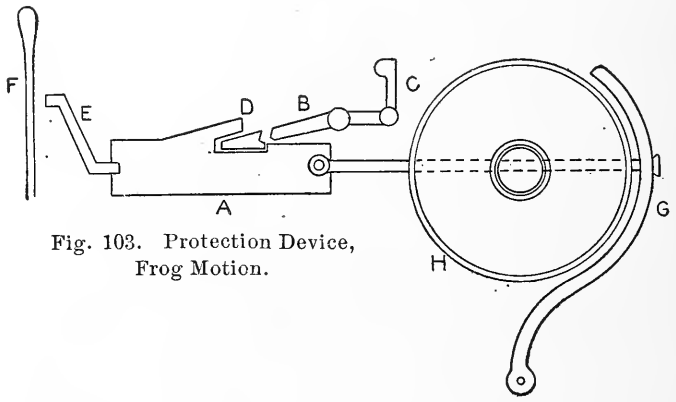


Fig. 103. Protection Device, Frog Motion.

THE PROTECTION DEVICE.

The protection device is to protect the warp from being broken out should the loom stop or bang off with the shuttle in the shed. There are two distinct forms of protection devices; first the frog motion, which is almost invariably used in connection with a back binder; second the device which has the dagger in the center of the lay and is used in connection with a front binder.

Referring to Fig. 103, which represents the frog motion, the explanation is as follows. A is the frog fitted on the side of the loom; B, the dagger attached to a rod suspended under the lay

sole; C, the protection finger which is fixed on the outer end of the dagger rod with its upper end in contact with the binder; D, the steel receiver placed loosely in the frog to receive the blow from the dagger point; E, knock-off finger which pushes off the shipper handle, F, when the dagger strikes the receiver in the frog; G, a brake which is drawn in contact with the tight pulley, H, when the frog is forced forward. This checks the speed of the loom, and also throws on the pulley some of the jar caused by the loom banging off. Incorrect setting of the brake often causes the loom to become broken and the receiver to wear out before it should. The latter is replaceable when worn. Pieces, A, B, C, and D are fitted to both sides of the loom, but the complete device is only used on the driving side. At the opposite end, the device which is there termed a blind frog, is necessary to prevent the lay swinging forward at that side as would happen if only one receiver were used.

With this form of protection device more power is required to drive the shuttle than when front binders are used, because stronger springs are invariably used on the dagger-rod, and there is also more weight pressing against the binders due to the use of two daggers.

The daggers vary in length, but for this style device on a narrow loom the average length would be about $3\frac{3}{8}''$. Different systems of setting are employed to the same end. One system is to draw the lay forward with the shuttle in the shed until the reed is pressing the shuttle lightly against the warp, at which time the dagger should come in contact with the receiver, and the brake bind on the pulley. Another method is to place the shuttle on the race-plate against the reed, and draw the lay forward until the front side of the shuttle is about $\frac{5}{8}''$ from where the fell of the cloth will be. This may be readily determined from the inside edge of the temple. Setting by this method will cover nearly every case regardless of the make of loom. Where an extra large shuttle is used, or very heavy fabrics are being woven, either protect sooner, or have the dagger a trifle longer.

On the ordinary Northrop Loom, an extra large shuttle is used, this being necessary to give the requisite strength when forcing the bobbin through, and a $\frac{5}{8}''$ space between the shuttle and the fell

of the cloth has been found to be amply sufficient. Smashes occur continually if the amount of space allowed is insufficient, even though the motion acts, and the cloth produced has defects in the form of thick places caused by the filling being beaten in too closely at the point where the shuttle comes to rest. The diagram at Fig. 104 shows the various positions. At A the position in weaving; B, when the loom has banged off and the shuttle is pressed forward until the protection acts; C, when the space allowed is insufficient and the yarn is tightened excessively. A third method of setting the device is to have the dagger in contact with the receiver when the crank shaft is slightly forward of the bottom center.

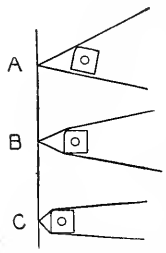
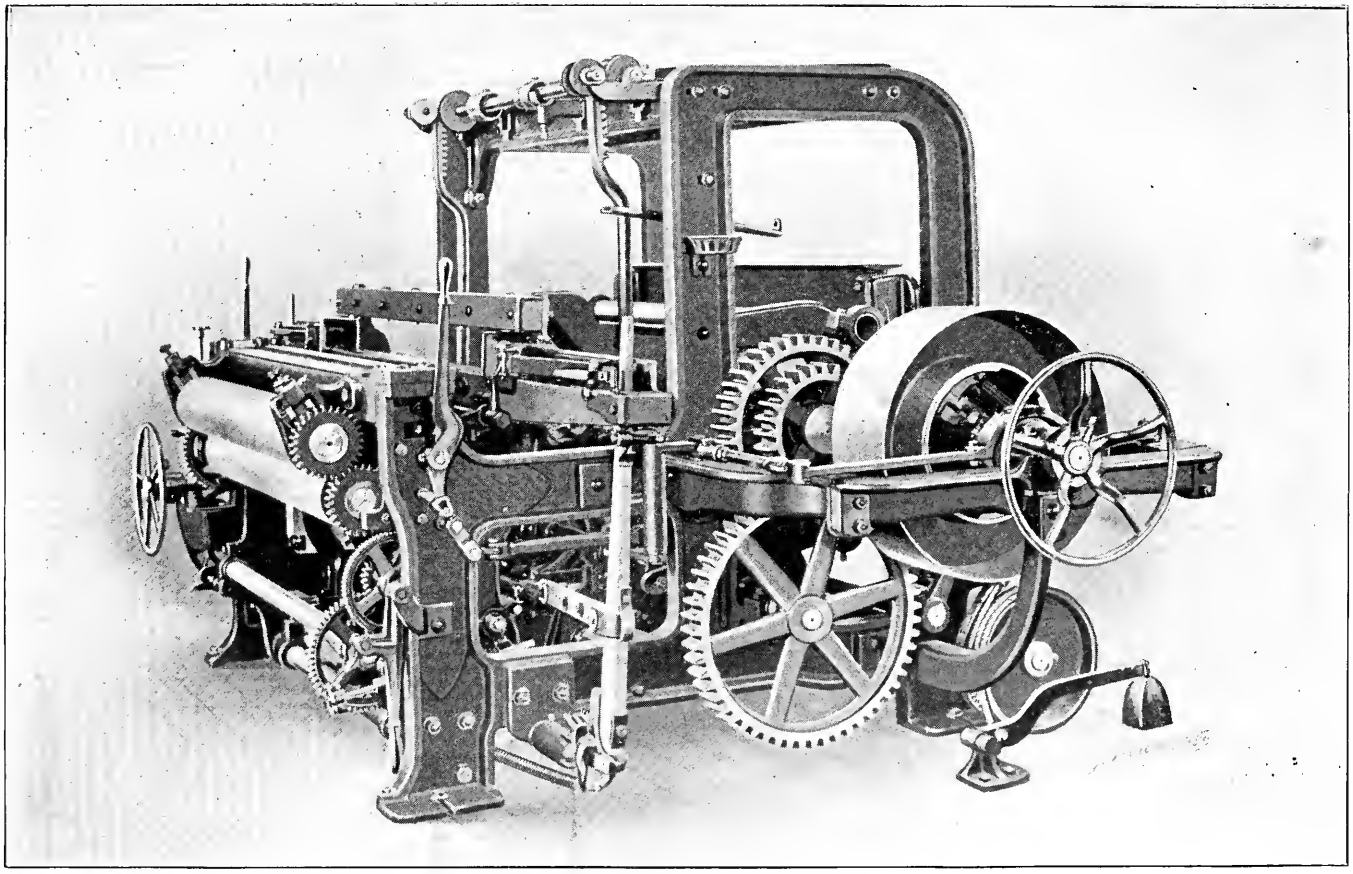


Fig. 104.

The other form of protection device is represented at Fig. 105. This form of device is in more general use than the one previously described both for single and multiple box looms, and is undoubtedly the better of the two. It is more easily fixed, does not require so much spring on protection rod, has fewer pieces, requires less power to drive the shuttle, and is used in connection with the front binder which is decidedly the most preferable form of binder. As illustrated, the various pieces are: A, the shuttle boxes; B, the protection finger; C, the dagger; D, the receiver; E, the protection spring; and F, the protection rod. The rod is held in close contact with the lower front of the lay sole, and the fingers, B, B, press against the binder or binder frame. Some makes of looms have only a binder forming the front of the box, while others have a wood front with an adjustable binder attached to the binder frame and fitted into an oblong slot cut in the wood front. Daggers vary in length for this form of device also, being from 4″ to $4\frac{3}{4}$″ long on a narrow loom, and correspondingly longer for broader looms because of the longer sweep of the lay. They are also made longer for narrow looms intended for very heavy weaving.

This form of motion is set similarly to the frog motion. To set the fingers, draw the lay forward until the dagger is well into the hollow of the receiver and fix one finger. Then insert a piece of cardboard about $\frac{1}{32}$″ thick between the finger and the binder, and fix the other finger in contact with the other binder.



KNOWLES EXTRA HEAVY DUCK LOOM
Crompton & Knowles Loom Works

When the second finger is being driven on, the rod has a tendency to spring a little and it is to allow for this that the paper is inserted. Have the dagger point strike squarely in the receiver for if it strikes either nearer the top or bottom the point of the dagger and the edges of the receiver soon wear out, and the first intimation of this is a smash in the warp, especially if the dagger has been striking against the bottom of the receiver. When the dagger is set to strike high up on the receiver it requires a greater amount of movement to keep it clear from the receiver when the loom is running. This means that the binder must be set closer into the box, causing increased pressure on the shuttle and a consequent increase of power necessary to drive the shuttle into the box. Under these conditions the loom will be constantly banging off because the slightest change in speed will prevent the shuttle from entering the box fully, and consequently the dagger fails to clear the receiver. There is also more wear which is due to the additional amount of movement required.

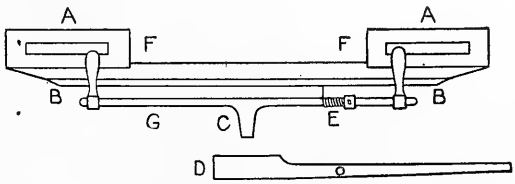


Fig. 105. Protection Device.

Tension on the spring should be as light as possible, only to the extent of keeping the finger in contact with the binder and applying sufficient pressure to the shuttle. The only real objection to this style of protection device is that all the jar caused by the loom banging off is applied at one point, and occasionally a breast beam is sprung or broken by reason of this. Neither of these faults will occur, however, if the breast beam is of well seasoned wood and free from dry rot. Incorrect setting of the brake is sometimes responsible for the trouble. The brake should be applied when the dagger strikes the receiver, for this tends to stops the momentum of the loom.

KNOWLES GINGHAM BOX LOOMS.

The term *box loom* is applied to a loom which is fitted with two or more boxes at one or both ends of the lay. A loom equipped with several boxes at one end of the lay and only one at the other, is always fitted with an alternate picking motion and only

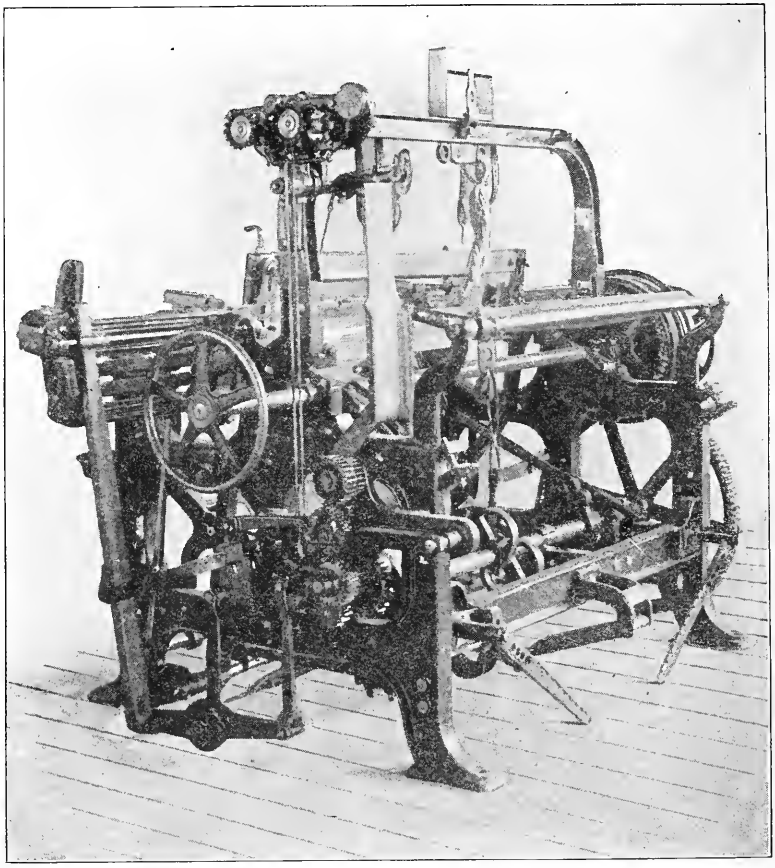


Fig. 106. Knowles Gingham Box Loom.

an even number of picks of any color may be woven into the cloth, because the shuttle having been picked across from the multiple box to the single box, must be returned to the multiple box before any change may be made. This type of loom, which is designated as a 2 by 1, 4 by 1, or 6 by 1 box loom, will be explained first.

The purpose of such looms is to produce cloth into which several different colors of filling are woven but only even numbers of picks of any one color may be used. The more boxes there are, the greater variety of patterns may be woven, but it is not advisable, however, to purchase looms having four boxes merely on the prospect of using four at some future time when only two are required for present needs. Unless the larger number of boxes are required for use in the immediate future, it is better to obtain only those necessary at the time. This may be explained by the fact that the shuttles are thrown differently from new boxes than from boxes which have been used. It is also difficult to obtain the right amount of leverage, and as all the shuttles from the multiple box are picked into the single box there is endless trouble from this source.

All the shuttles used for these looms must be as nearly equal in size and weight as possible, and should as well be in good proportion to the boxes. If they are too small the top edge of the back of the shuttle receives no support from the back of the box, and has a tendency to work in the slot or picker-race in the back of the boxes, while if too large, broken bobbins will often result and the shuttle require more power to drive it into the box, especially in the case of the temple being set a little high off the race-plate. There should be a space of not less than three-sixteenths of an inch in the box both above and in front of the shuttle. Two very good reasons may be given for allowing this space. First, the temple almost invariably raises the yarn from the race-plate and even when very slight it is sufficient to raise the shuttle so that it has a tendency to strike the top of the box, unless space is allowed, thus retarding the shuttle, chipping the wood, and breaking bobbins and yarn. Second, the shuttle travelling across the lay describes an arc, with the tendency for the shuttle to strike the front of the box, and unless space is allowed here equally bad results will follow.

In judging the value of a box motion two considerations ought to be taken into account as follows: Is the motion adapted to the speed of the loom to which it is to be fitted, and are the parts readily changed and easily adjusted when fitting is required? According to the practical answers to the above the returns are good or bad. A box motion may appear to be simple and yet not be

suitable for the work it is expected to perform, while on the other hand a complex mechanism is not usually a very durable one. A solid compact motion is to be desired, especially for high speed looms, because a motion, the main working parts of which depend upon small studs for support, will not run long without repairing, even though good results could be obtained with slightly stronger parts on a slower running loom.

Fitting A New Set. Having selected the boxes, the next procedure is to fit them to the loom and a few moments examination of them may save hours of labor as well as supplies. A set of boxes may be fitted to a loom in such a way that the shuttles will run a month without any appreciable effect, or they may become spoiled in an hour, according to the precision of fitting. Of course boxes must be fitted to a high speed loom with the greatest possible care, or the back of the shuttles will soon become worn and splintered. Clean the boxes thoroughly, wiping away all grease from the inside of the boxes, particularly as its presence would cause false running of the shuttles. Smooth off all sharp edges such as are found on the inside edge of the back slot and the edges of the groove in the binder. Set all the binders so that each shuttle will be gripped at similar points; binding the shuttle at or slightly behind the center for reasons referred to in a previous chapter on Binders. Do not allow all of the flat end of the binder to come in contact with the box, or the filling will become cut, because as the shuttle leaves the box the filling curls and usually drops in between the binder and the front of the box, and when the binder comes in contact with the front of the box the filling is cut, while if the binder touched only at the extreme end there is no danger of this happening. After the binders are bent to fit the shuttle, the extreme end of the binder should not be in contact with the outside pin, but wherever possible a space of at least one-quarter of an inch should be allowed for change. With a new set of boxes the binders must be tighter than is necessary with an old set, due to a certain amount of grease which it is impossible to remove, and the shuttles as well are inclined to be oily.

Set the lifting rod thoroughly by means of the lock-nut underneath the boxes. Carelessness in regard to this is a source of trouble as the boxes become loose, and during the picking of the

shuttle the front of the box descends, causing the shuttle to strike the race-plates with harmful effect. A loose lock-nut is also a common cause of the boxes binding in the slides.

The above directions apply to the fitting and fixing of boxes regardless of the motion employed to actuate them. Before describing the setting of the boxes, due consideration must be given the box motion. The box motion used on the two-harness gingham loom consists of two parts, the Upper and the Lower, the latter of which will be explained first because it is connected directly to the boxes.

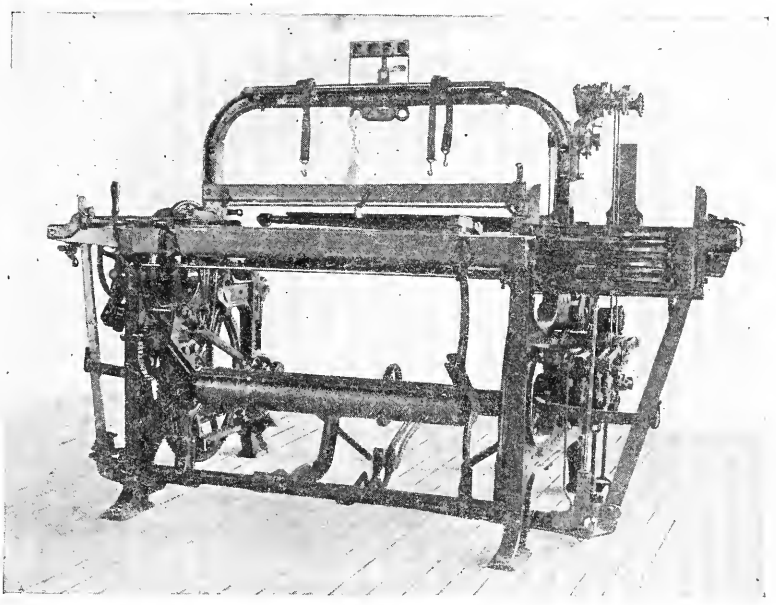


Fig. 107. Knowles Gingham Box Loom.

KNOWLES BOX LOOM LOWER MOTION.

This box motion derives its movement from elliptical gears, and consequently has a fast and slow motion. The gears are timed to impart their greatest speed during the change from one box to another, which regulates the color of filling to enter the cloth. While it is not only advisable but necessary to have the boxes changed in time, it is not always desirable to have too rapid action,

for the movement should be as even as possible. A jerky action in changing boxes is constantly causing trouble. A diagram of the gearing of this motion is presented at Fig. 108. Elliptic gear

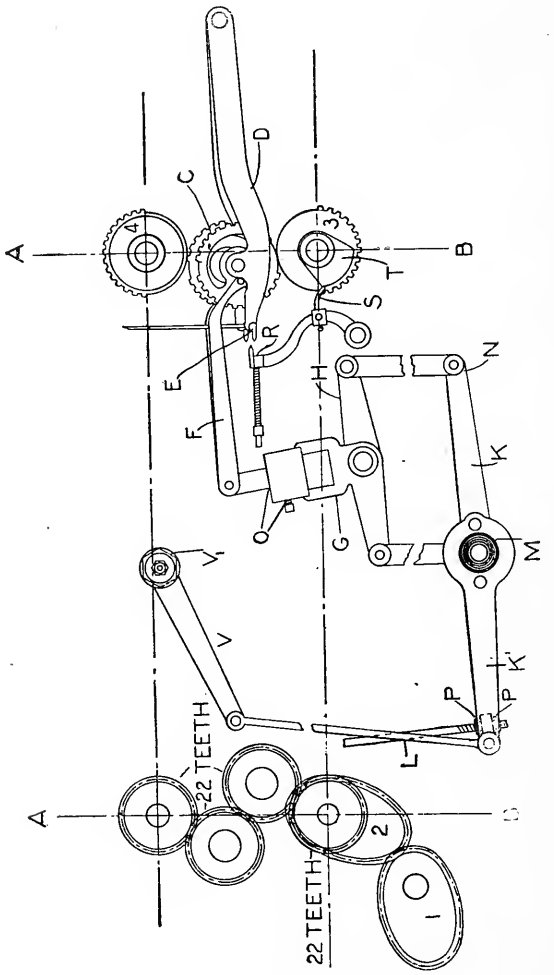


Fig. 108. Diagram of Gearing. Knowles Box Loom Lower Motion.

1, is fixed on the picking cam shaft and geared into 2, each having 27 teeth. Compounded with 2 is a 22-tooth gear and a segment gear 3, which has 15 teeth. The 22-tooth gear is the first of a train of four gears of the same number of teeth, which transmit

motion to the second segment gear 4, also of 15 teeth. The vibrator gears, which are placed in a position between the segment gears, have one tooth omitted from one side and three from the other, motion being imparted always through the smallest space, the first two teeth of the segment entering that space. The larger space is to allow the segments to revolve without acting upon the vibrator gear.

The vibrator gears, of which there are two, are mounted on studs fixed to the vibrator leve s D, and these in turn are supported at one end by a stud attached to the loom side, the other end being connected by means of the connecting rods E, to the small levers which press on the filling chain bars. A vibrator or connecting bar, F, is fixed by means of a stud to each vibrator gear, both vibrators also being attached to the box levers, which impart the rise and fall to the boxes. One of these levers is a compound lever, G, which will raise or lower two boxes, and the other is a single lever, H, which will raise or lower one box. The pieces, K, and, K′, act as one solid lever during the ordinary working of the loom, and the two box levers, G and H are attached to K and K′ at points M and N respectively. The box lifting rod is attached to the outer end of K′, being adjusted by means of the adjusting nuts at P. Leverage is increased or diminished at O, increased by lowering the connection and diminished by raising the connection.

A cam, T, placed on the same shaft as segment gear, 3, actuates the lock-knife, R. This knife engages with the ends of the vibrator levers, keeping them in position during the time the segment gears revolve. If they were not so held they would tend to spring out of contact with the shells, forcing the lock-knife out of connection with the vibrator levers during the changing of the box chain, and allowing the bars to be raised or lowered. To time the lock-knife, set the finger, S, on the center of the highest part of the cam, when the crank shaft is between the bottom and front centers, inclined to the front center, with the shuttle in the single box.

A protection device is provided to protect the mechanism from becoming broken at any point, if anything should happen to prevent the boxes from working. Sometimes a shuttle does not fully enter the box, leaving part of it extending on the race-

plate, and if some device were not provided to free the boxes, either the shuttle or the boxes would be broken. The manner of joining together the levers, K, and, K′, provides this protection. Two short studs with tapered ends are set into the hub of lever, K′, and fit into corresponding holes in the hub of lever, K, the two levers being held in close contact by means of a spiral spring, which is held compressed between the head of the bolt and the lever. When the boxes are prevented from working, the studs in lever, K′, twist out of the holes in lever, K, thus breaking the connection, which will be re-established on the removal of the obstruction. A spring at V′ in the box of lever, V, assists in drawing the levers back into place.

To Set the Boxes. Place the boxes in the slides and attach the lifting rod to the swivel, P. Bend the lifting rod very slightly away from the loom at a point near its center, in order to elevate the back end of the boxes and thus guide the shuttle higher on the picker. Loosen the bottom of the lifting rod and adjust the slides so that the boxes may be raised freely, but not loosely, as the latter is detrimental to good work. Set the boxes by means of the adjusting nuts at P, so that the bottom of the top box at the entrance is level with the race-plate. Then raise the second box by means of the box motion, and level the bottom with the race-plate by changing the connection of the single lever at O; raising the connection to lower the box or lowering the connection to raise the box. Next raise and adjust the third box similarly to the second. The fourth box should be all right after the former adjustments, and if not, it is an indication that the boxes are not true. This is occasionally the case, caused by the boxes becoming bent before leaving the machine shop. It must be remembered in connection with this motion, that changing the adjusting nuts at P will alter all the boxes, and the adjustment of the second and third boxes must be effected by altering the connections of the single and compound levers at O, therefore the top box must be adjusted first and the others in order.

Always bend the lifting rod at the center, because if the bend is higher it will rub against the frame work of the boxes, and if lower it will come in contact with the supporting bracket, in either case causing endless trouble. As the shuttle is brought forward

by the picker, it should be so driven that its front end is inclined toward the reed, this method of driving tending to cause the shuttle to run better across the lay. This may be brought about by having the back end of the boxes forward, out of a straight line with the reed, or by having the back end of the picker spindle forward, out of line with the back of the box. The parts are sometimes fitted in this manner in the machine shop, but if they are not, the fixer should see to it that they are.

Patent buffers and checks are made to be fitted at the end of the box frame behind the picker, but in place of these a roll of cloth or several layers of leather tacked together, may be used. Such checks serve a two-fold purpose, that of reducing the jar on the shuttle when it reaches the end of the box, and also to keep the picker-face level with the guide plates, the latter being an essential feature in the running of a box loom. Fig. 109 shows the guide plates which press out the shuttle when the boxes change if the picker is too far back from the face of the slide.

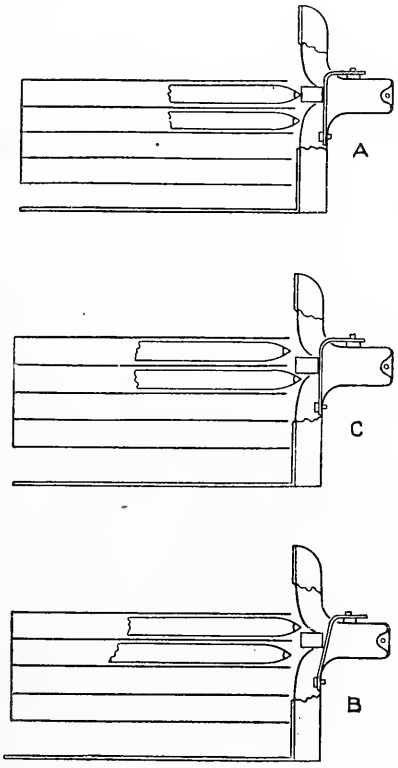


Fig. 109. Guide Plates.

If the picker is allowed to remain in that position, the tip of the shuttle eventually wears flat with sharp edges which cut the warp yarn. Occasionally the shuttle being back too far will catch, and preventing the boxes from sliding freely, cause a smash. For a buffer or check to the picker on the inner end of the picker-

spindle, a strip of leather doubled three or four times will give good service, and if a leather or rawhide washer is placed in between each doubling, the check will last much longer.

Previous to placing the picker on the spindle, be sure that it is perfectly straight, for it is not worth while trying to fix a warped picker as it will never give satisfaction.

The normal position of the vibrator gears is with the small space on top, and it may readily be seen that in order to accommodate the risers on the chain, it is necessary to have the vibrator gears almost rest on the lower segment gear, hence the space is necessary on the bottom of the vibrator gears to allow the bottom segment to rotate freely. When the boxes are to be raised, a riser is placed on the box chain, to lift the small lever connected to the lifting rods, which in turn lifts the vibrator bar and vibrator gear, which is mounted on the bar. This brings the vibrator gear into position so that the first tooth of the segment gear enters the space in the vibrator gear, which is then rotated one-half turn, drawing with it the vibrator lever and consequently raising the box lever. The vibrator gear now being turned half round the large space, is on top, thus allowing the top segment gear to revolve freely. This position will be maintained until a blank bar in the chain comes under the small lever, thus through the connections allowing the gear to drop into contact with the bottom segment gear, which, rotating in the opposite direction to the top one, returns the vibrator gear and the boxes to their first positions.

Timing the Box Motion. Set the box motion so that when the boxes are changing up or down, the bottom of the box will be about one-eighth of an inch above or below the race-plate, when the dagger is in contact with the receiver. Or, have the first tooth of the segment in contact with the vibrator gear when the crank shaft is just behind the bottom center, coming forward.

Upper Box Motion. The upper box motion consists mainly of two barrels or cylinders, with the necessary driving mechanism, which carry the box or filling pattern chain and the multiplying chain. A detail sketch of this motion is given at Fig. 110, lettered for reference as follows:

A. Box chain ratchet, which is fixed to the filling chain barrel.

B. Small lifting lever which rests on the box chain. There are two of these, one for the single lever and one for the compound.

C. Connecting rod which connects lever, B, with the vibrator bar in the lower box motion, in the sketch of which it is lettered E. There are two connecting rods, one for each lever.

D. Multiplying ratchet which is fixed to the multiplier chain barrel.

E, E′. Elbow lever.

F, G. Driving pawls which are mounted on the upper end of E and work in opposite directions.

H. Small lever which rests on the multiplying chain.

J, J′. Slide or shield controlled by H.

K. Small lever same as H which rests on the box chain.

L, L′. Shield controlled by K.

M. Small clamp fitted around the box of elbow lever, E, E′.

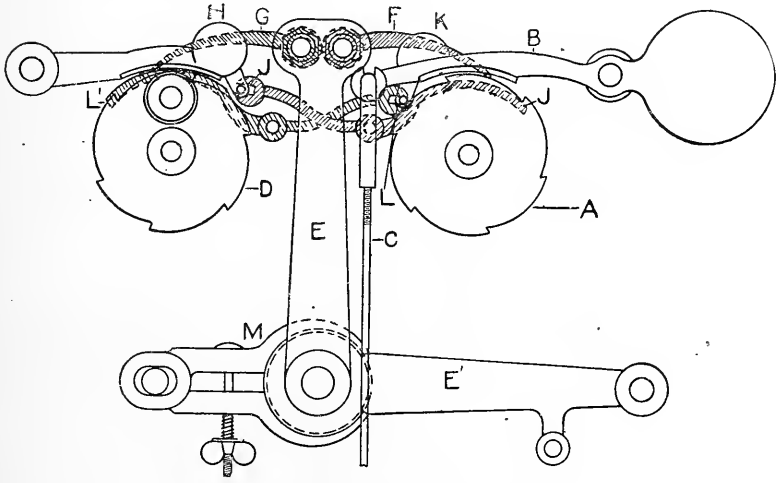


Fig. 110. Upper Box Motion.

The motion is driven through a connecting rod with a disconnecting device from a shell cam fixed on the pick-cam shaft. A stud is bolted to the loom side, forming a bearing for one end of a small lever which carries two studs at the other end, one on each side. One of these studs works in the shell-cam, and the connect-

ing rod, A, (Fig. 111) is attached to the other. At the upper end of this connecting rod, A, is attached this disconnecting device in the form of a slotted lever, B, with a semi-circular recess in which a stud, D, is held during the operation of the motion, this stud being fixed at the end of the elbow lever. Ordinarily the disconnector fits over the stud, and as the connecting rod moves up and down the lower part of the elbow lever moves with it, thus causing the upper part to vibrate between the chain barrels actuating the pawls which are mounted on its upper end. A chain or cord, F, connects the filling fork slide to the back of the slotted lever, and consequently when the filling runs out or becomes broken, the lever is drawn back against the pressure of spring finger, E, which ordinarily holds it in position, in this way breaking the connection. Though the rod continues to act it is so held that the stud remains in the slot, not being allowed to engage in the recess and consequently the elbow lever is not actuated. This action of the disconnector prevents the occurrence of mispicks by stopping the turning of the box chain. The clamp, M, holds the elbow lever in a fixed position when the rod is disconnected.

Timing the Cam. When the crank shaft is on the front center with the shuttle in the single box, set the cam so that it will commence to draw down the rod, and the pawl will commence to turn the box chain.

Chain Building. Risers are small iron rollers which are placed on the chain bars to pass under and raise the small lifting levers which through the connecting rods actuate the box motion and thus raise the boxes. A riser is always a starter.

Sinkers are small iron tubes which are placed on the chain bars to keep the risers in position, also being used where risers are not required, *i. e.*, when the motion is not to be changed or is to be returned to its regular position.

When there are but two shuttle boxes to be controlled by the motion, one space only is required for a riser or sinker on the chain. Four boxes require two spaces, six boxes require three spaces and when a multiplier is used at least one space more must be allowed. In the consideration of chain building it is as well to start the subject with building the box chain alone, leaving the multiplier until later, and the four-box motion just described is a

good example on which to work. The main facts to be borne in mind are that the single lever will raise or lower one box and the compound lever will raise or lower two boxes.

A riser placed on the chain to actuate the single lever will lift the boxes from first to second; a riser placed on the chain to actuate the compound lever will lift the boxes from first to third and a combination of the two will lift the boxes from first to fourth, irrespective of the previous bar. To return the boxes to

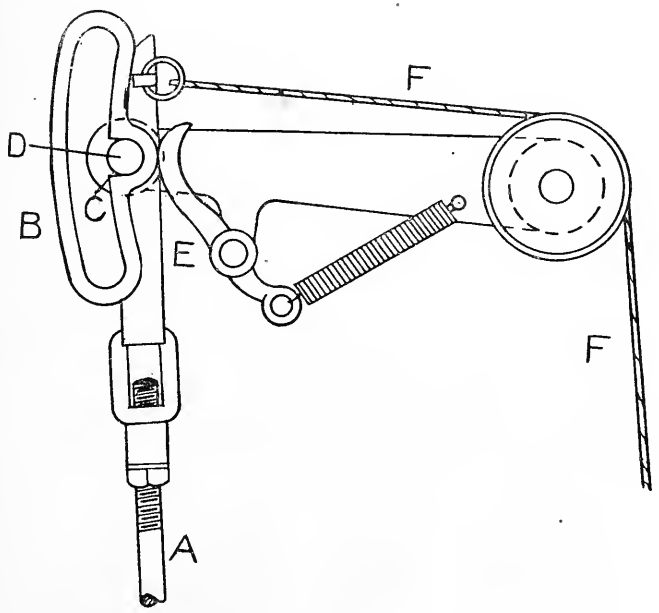


Fig. 111. Disconnecting Device.

place, build as follows: To return from fourth to second a riser under the single lever; fourth to first, a blank bar; third to second a riser under the single lever; second to first, a blank bar, fourth to third, a riser under the compound. The boxes are in the regular or normal position when the bottom of the top box is even with the race-plate, and a blank bar, *i. e.*, a bar containing sinkers only, is necessary to retain this position, but risers must be used to cause a change. When possible to avoid it, never build a chain so

as to cause the boxes to jump from first to fourth or fourth to first, because in so doing the motion is subjected to a greater strain than it should be, and constant fixing will be required. If soft or loosely spun filling is being used in one shuttle, run that shuttle in the top box to prevent the fibres of the loose filling from clinging to the other filling and causing a bad selvedge.

Example: Suppose a chain is required to weave the following colors, 4 red, 4 white, 4 red, 4 white, 2 black, 2 green, 2 black, 4 white, 4 red, 4 white, making 34 picks in the pattern. Each bar in the chain has the value of two picks because the shuttle passes from the multiple box to the single box and back again, before a change can be made, and for 34 picks 17 bars are required. Place the red in the top box, the white in the second box, the black in the third box, the green in the fourth box. Then the chain would be built according to the following directions:

4 picks of red will require two blank bars or sinkers.

4	"	" white	"	a riser under the single lever, and a sinker under the compound lever, on two bars.
4	"	" red	"	two blank bars.
4	"	" white	"	a riser under the single lever, and a sinker under the compound lever, on two bars.
2	"	" black	"	one bar with a riser under the compound lever, and a sinker under the single lever.
2	"	" green	"	one bar with a riser under both single and compound levers.
2	"	" black	"	one bar with a riser under the compound lever, and a sinker under the single lever.
4	"	" white	"	a riser under the single lever and a sinker under the compound lever, on two bars.
4	"	" red	"	two blank bars.
4	"	" white	"	a riser under the single lever and a sinker under the compound lever, on two bars.
34				

The above is indicated on design paper as shown in Fig. 112; C, meaning compound lever; S, single lever; x, a riser; and —, a sinker. Any chain where a multiplier is not used, may be laid out in a similar manner by increasing or decreasing the number of bars as required, using one bar for each two picks.

The Multiplier. The multiplier is of great value as its use saves time in building box chains, and also reduces greatly the length of chain required. It is especially valuable when large

check patterns are to be woven, for however large the pattern is, the multiplying chain can be so built as to reduce the box chain to a comparatively small number of bars. In mills where blankets are woven it is customary to use a double and occasionally a triple multiplier, one multiplying the other. The multiplier does not control the box motion, but does control the box chain, giving to every bar in the box chain, which carries a multiplying riser on it, the value of the multiplier itself, whatever that may be. A multiplier has for its value twice as many picks as there are bars in the chain without repeat, *i. e.*, a 4-pick multiplier would require only two bars one blank and one carrying a box chain riser, but these would have to be repeated to give sufficient length of chain to go around the chain barrel. The multipliers most commonly used are 4, 6, 8, 10, 20, 30, and a bar in the box chain carrying a multiplying riser has the respective value as indicated, because the box chain will remain stationary while that number of picks are placed in the cloth. The box chain is stationary while the multiplier is working, and the multiplier is stationary while the box chain is working, a riser always being the starter or changer from one chain to the other.

S.	C.
—	—
—	—
x	—
x	—
—	—
—	—
x	—
x	—
—	x
x	x
—	x
x	—
x	—
—	—
—	—
x	—
x	—

Fig. 112.

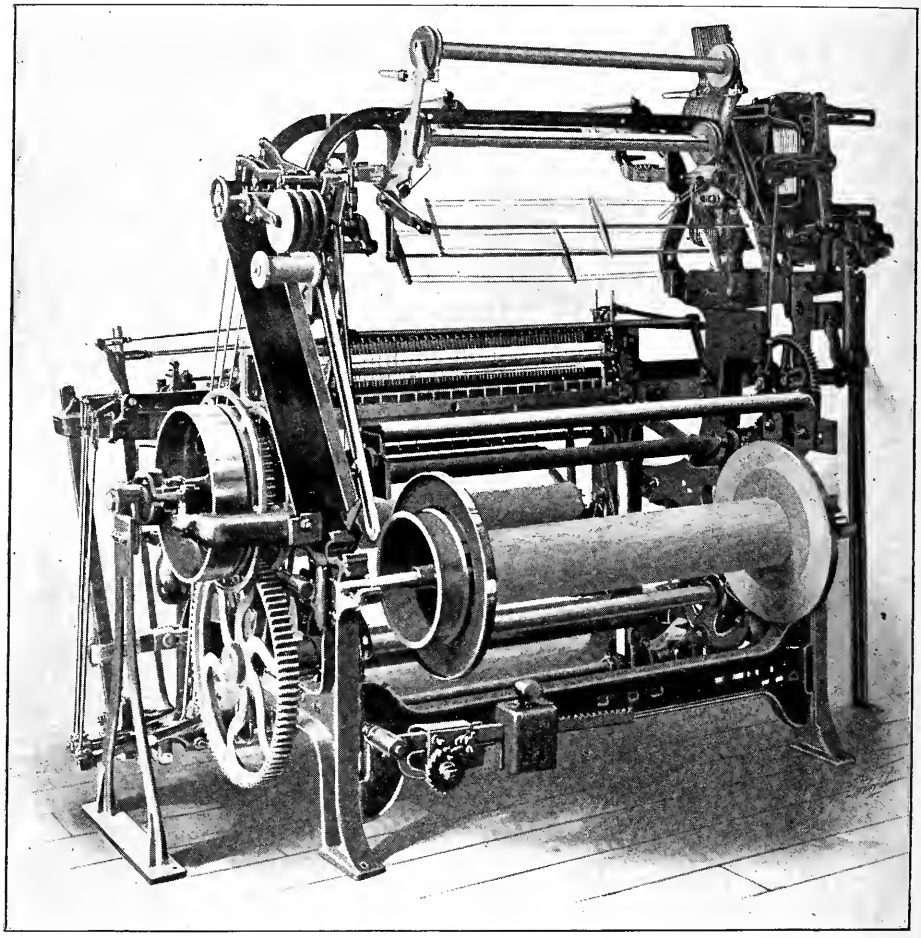
A multiplying riser on the box chain starts the multiplier and stops the box chain, which starts again when a riser comes up on the multiplier chain. The multiplier which will reduce the length of the box chain to the greatest extent, without requiring an excessively long multiplying chain, should always be selected. In a pattern having 20 picks of one color and 10 each of two other colors it would seem as though a 20-pick multiplier would give the greatest amount of reduction, but this is not the case, as a 10-pick multiplier instead would be better. A multiplying chain may be used continuously for two or more repeats, adding a bar with a multiplying riser to the box chain for each repeat, or for any number of picks greater than its value, by adding one bar to the box chain for every two picks extra, but it cannot be used for a number

of picks smaller than its value, hence the reason for the statement that a 10-pick multiplier should be used for the given pattern. As a proof, for a pattern composed of 20 white, 10 black, 10 red, using a 20-pick multiplier, one bar, carrying a multiplying riser, would be required for the 20 picks of white, five ordinary bars would be required for the black, and five for the red, making 11 bars in all with 10 bars in the multiplier chain, a total of 21. Using a 10-pick multiplyer, two bars carrying multiplying risers, would be required for the white, and one each, carrying multiplying risers, for the black and red, making 4 bars for the box chain, which together with the 5 bars required for the multiplier would make a total of only 9 bars.

As a further example, suppose the pattern is required to be composed of 20 pink, 20 white, 20 pink, 10 white, 2 cord pink, 10 white, 20 pink, 20 white. Working out the chains for this pattern to find whether a 20-pick or a 10-pick multiplier would be better, the result would be as follows:

Picks.	10-Pick Multiplier.	20-Pick Multiplier.
20 pink	2	1
20 white	2	1
20 pink	2	1
10 white	1	5
2 cord pink	1	1
10 white	1	5
20 pink	2	1
20 white	2	1
	13 bars	16 bars

For this pattern also the 10-pick multiplier would require the shorter chain, 13 bars being required for the box chain with the 10-pick multiplier, and 16 bars being required with the 20-pick multiplier. If the length of the multiplier chain is also taken into account, the difference becomes still more favorable to the 10-pick multiplier, as 13 box chain plus 10 pick multiplier = 18 bars, total required, using a 10-pick multiplier; and 16-box chain plus 20-pick multiplier = 26 bars, total required using a 20-pick multiplier. The length of the multiplier chain, however, should not receive too much consideration as in building a multiplier chain it is only necessary to place a single riser on one bar as a changer.



REAR VIEW OF 3-BAR LAPPET LOOM WITH PLAIN LAY
Crompton & Knowles Loom Works

As a pattern where a larger multipler will allow the use of a shorter box chain, the one worked out as follows is a good one.

	16-Pick	8-Pick
Picks.	Multiplier.	Multiplier.
26 Dark Green	6	4
16 Medium Green	1	2
16 Light Green	1	2
16 Medium Green	1	2
4 Black	2	2
16 Medium Green	1	2
16 Light Green	1	2
16 Medium Green	1	2
	14 bars	18 bars

In this instance also the smaller multiplier requires the larger number of bars in the multiplier chain because one repeat of the chain is not long enough to go around the chain barrel and two repeats would have to be made. For the 26 picks the 8-pick multiplier repeats three times, giving 24 picks to 3 bars in the box chain with one ordinary bar for the two picks over, making 4 bars for the 26 picks. For the 16 picks the multiplier repeats twice, having two bars in the box chain, and for the four picks black two ordinary bars are required with the multiplier stopped. Careful judgment must be used in arranging the colors in the boxes. In all ordinary cases the best method is to place that color of which most is used, in the top box, but when this necessitates jumping more than two boxes the colors should be placed differently according to the limitations imposed. This arrangement may easily be used for the pattern in hand, placing the Dark Green in the first box, Medium Green in the second, Light Green in the third, and Black in the fourth.

Picks.	Color.	Box.
26	Dark Green	1
16	Medium Green	2
16	Light Green	3
16	Medium Green	2
4	Black	4
16	Medium Green	2
16	Light Green	3
16	Medium Green	2

The box and multiplier chains are now worked out on design paper as illustrated in Fig. 113.

Start the chains with the riser in the multiplier chain on the top, so that the front end of the shield is clear from the teeth of the box chain ratchet. This allows the pawl to turn the box chain, and if the first bar carries a multiplying riser it will cause the front end of the shield to clear the multiplier ratchet, which is

BOX CHAIN.			MULTIPLYING CHAIN.
M.	S.	C.	
x	—	—	—
x	—	—	—
x	—	—	—
—	—	—	x
x	x	—	
x	x	—	
x	—	x	
x	—	x	
x	x	—	
x	x	—	
—	x	x	
—	x	x	
x	x	—	
x	x	—	
x	—	x	
x	—	x	
x	x	—	
x	x	—	

Fig. 113.

then turned bringing up a blank bar or sinker, thus allowing the back end of the shield to be down with the front end covering the teeth of the box chain ratchet, so preventing the box chain from being turned. The shield of the multiplier being clear, owing to the riser on the box chain, the multiplier works around until the riser comes up, which clears the shield from the box chain ratchet, and the box chain is again started up.

From the above it is readily seen that it is the multiplying riser on the box chain which starts the multiplier, and it is the

riser on the multiplier which again starts the box chain. If both chains were so set that a sinker came at the top of each, neither one would be turned and only one color of filling would be woven into the cloth.

Worn vibrator gear studs and worn studs in the protection lever are the most frequent causes of trouble in this form of box motion. When the latter becomes worn or the spring is too weak, the lever slips and the boxes are not lifted high enough. If the gear stud is worn there is a tendency for the gear to become sprung or the first tooth to break. The first two or three teeth in the gear and segment become worn and allow them to spring out of mesh. Incorrect timing of the lock-knife will cause skips, and incorrect timing of the chain barrel will cause broken risers and bent chains. Care must be taken in timing the boxes and fitting the swells, as previously explained. Sometimes when a loom bangs off with the shuttle partly in the shed, a smash results, due to the boxes being set early so that the protection finger is in contact with the edge of the swell, preventing the protection from working. A protection finger, worn so that the flat part rests against the other binder, will occasionally cause a smash in a similar way. If there is insufficient movement given to the dagger, owing to faulty fixing of the binder by bending out the end instead of shaping it properly, smashes often occur, and in addition the inner part of the binder will cut the filling by pressing against the box frame.

To Prevent Filling from Drawing, first examine the filling, and if one shuttle contains soft spun filling it should be placed in the top box, as it is almost impossible to prevent the filling from drawing in if the soft filling is between the others, because it causes them to cling together. If the shuttles cannot readily be changed, or if the filling is all alike, bend a piece of wire into a bow and fix it in the lay sole near the box entrance, with about one and one-half inches extending above the race-plate. Should this not answer the purpose, fix a narrow band of leather to the boxes near the entrance, extending from bottom to top. Avoid as far as possible jumping the boxes from first to fourth or from fourth to first, especially the latter, as the tendency to rebound is greater on the descent than on the rise. Many fixers tighten up

the protection spring on the box rod, believing that the spring is only for that purpose, which of course is not the case. Its purpose is to protect the motion from becoming broken if the shuttle sticks in the boxes or if they are held fast by some other cause, and the tighter the spring is, the less protection will be given. Jumping of the boxes is usually due to incorrect timing of the eccentric gears. They will sometimes run well when the slow speed comes on at the finish, thus easing off the boxes, while at other times it is necessary to set them with the fast speed, just finishing so as to get the boxes started before the fast speed is put on, otherwise the chain travels more quickly than the boxes. Heavy lifting of the harnesses often influences the boxes, the heavy lift causing extra vibration to the upper motion.

CROMPTON GINGHAM LOOM, 4 x 1 BOXES.

The Upper Box Motion. Similarly to the Knowles Gingham Loom, the box motion of the Crompton Gingham Loom is composed of an upper and a lower motion. The upper motion consists of box chain, chain barrel and multiplier, together with the necessary driving pawls and ratchets as illustrated in Fig. 114.

The Multiplier. A disc multiplier is used on this motion, *i. e.*, a multiplier run without a chain. The disc, B, which has two indentations, C, in its circumference, carries a ratchet, A, of a variable number of teeth. Pressing against the disc is a small finger, acting in combination with a slide, D, on the same stud which extends under a pin fixed in the driving pawl, H. When the finger is held on the circumference of the disc the driving pawl is held out of contact with the filling chain ratchet, but when the finger enters the indentation the slide drops away, allowing the pawl, H, to engage with the ratchet and turn the filling chain. There is also a lever, E, pivoted on the same stud which carries the disc, one end of which extends over the chain at F, and the other extends directly under the end of the pawl, G, which operates the multiplier ratchet. When a multiplying riser comes up on the box chain it raises the lower end of the lever, E, and consequently lowers the upper end, allowing the pawl, G, to engage with the ratchet, A, thus turning the disc until the finger again enters an indentation. Then the slide, D, drops, allowing the

pawl, H, to engage with the filling chain ratchet which continues to turn until another multiplying riser comes up on the chain.

To change the value of the multiplier a ratchet of a different number of teeth is substituted. Each tooth has the value of two picks, but owing to the disc having two indentations the value of the multiplier is half the number of teeth in the ratchet. The value of a multiplier may readily be doubled by attaching a piece of tin to the disc so as to cover up one indentation, when its value will become double the whole number of teeth. The disc multiplier is an exceptionally good mechanism as it is simple, positive in action, and has no links to get out of order, thereby requiring very little fixing.

The upper box motion is operated through a double cam, A,

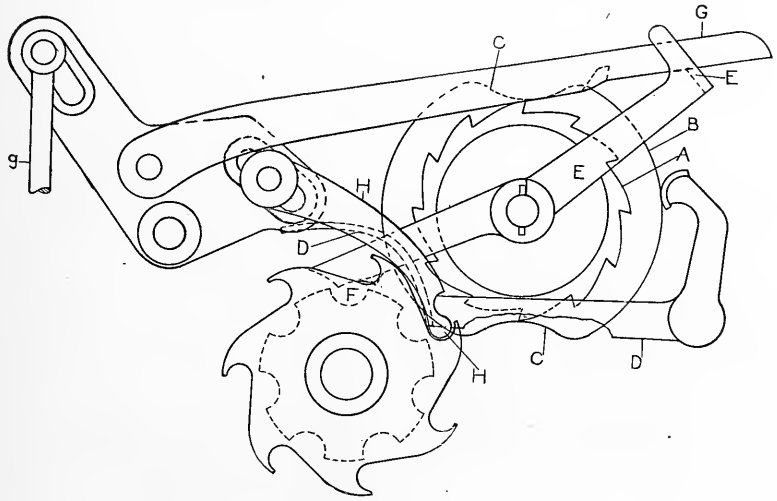


Fig. 114. Upper Box Motion.

(Fig. 116) fixed on the pick cam shaft, one part of which actuates, through the connections, the oscillating lever on which are mounted the driving pawls. A disconnector, which prevents the driving rod from working when the filling breaks, is actuated by the smaller part of the cam, which also assists in drawing back the motion after a disconnection has taken place. The dwell of the larger part of the cam is one-half a revolution of the pick cam

shaft, equal to a full revolution of the crank shaft, and the smaller cam has one-half the dwell of the larger. There are two separate elbow levers, C and D, between which the cams revolve, both being pivoted on the same stud, E, which is attached to the cross rail of the loom. A catch slide, L, is attached to the upper end of the lower elbow lever, D, at F, and the driving rod, G, which drives the upper box motion, is attached at the other end. The

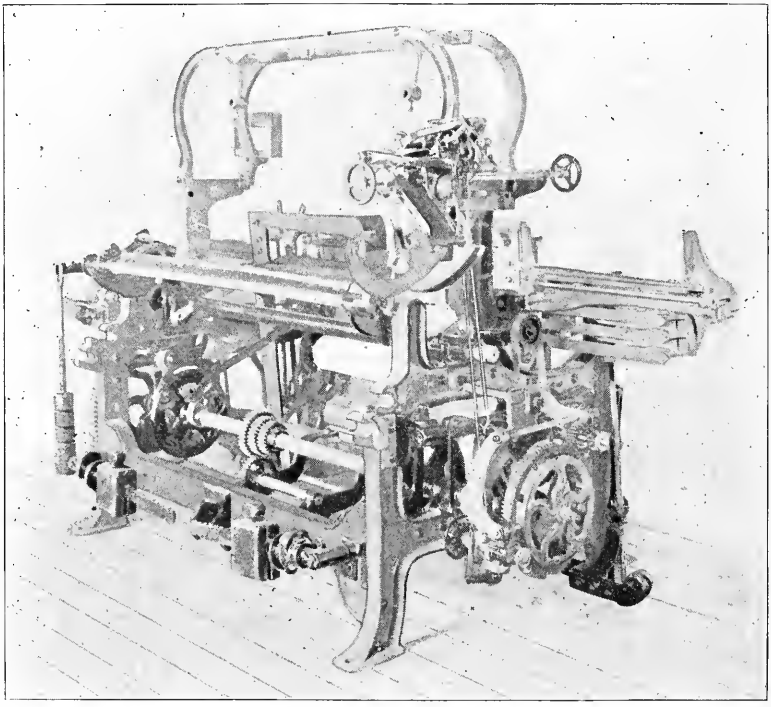


Fig 115. Crompton Gingham Loom.

upper elbow lever, C, is actuated by the large cam, and carries, fixed on a stud, H, at the elbow, a spring clamp which also grips a stud fixed in the upper part of the lower lever, D, at J. As the cams revolve, the large one coming in contact with the upper elbow lever, raises it, and by the combined action of the spring clamp and the spring, K, the lower elbow lever is also actuated. A slotted bar, M, is supported by a bracket fixed to the loom side, and the slide, L, works in the slot of this bar when the motion is

in operation. When the filling breaks, the fork-slide draws back and lifts a finger which is also in contact with the slotted bar, M, thus raising the slotted bar so that as the slide is driven forward the catch comes in contact with the bottom of the slot, with the result that further forward movement is prevented, and the stud on the lever, D, at J, is forced out of connection with the spring clamp. This stud being out of connection, the connecting rod cannot be lifted sufficiently high to cause the pawl to turn the

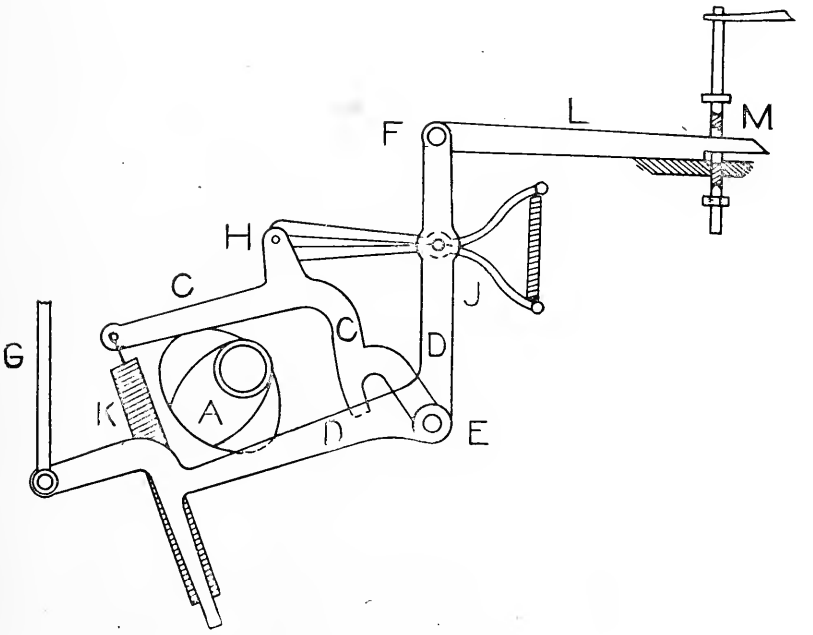


Fig. 116. Disconnecting Device.

ratchet gear on the filling chain barrel, and all operation of the box motion ceases. While the elbow levers are disconnected, the tension spring, K, is extended, and it will draw the upper elbow lever back into position when allowed to contract; this is called the grasshopper motion.

The Lower Box Motion. This motion, which is illustrated in Fig. 117, is known as the pin gear motion, deriving its name from the manner of driving the large segment or space gear, B.

The pin gear, also termed the dog, is attached to the end of the pick cam shaft, and as the shaft revolves, the pin, A, enters one of the recesses in the segment gear, B, advancing the gear one space for each revolution. There are ten spaces on the inside separated by recesses, and on the outside the gear is divided into ten segments of seven teeth each, with blank spaces between, so an

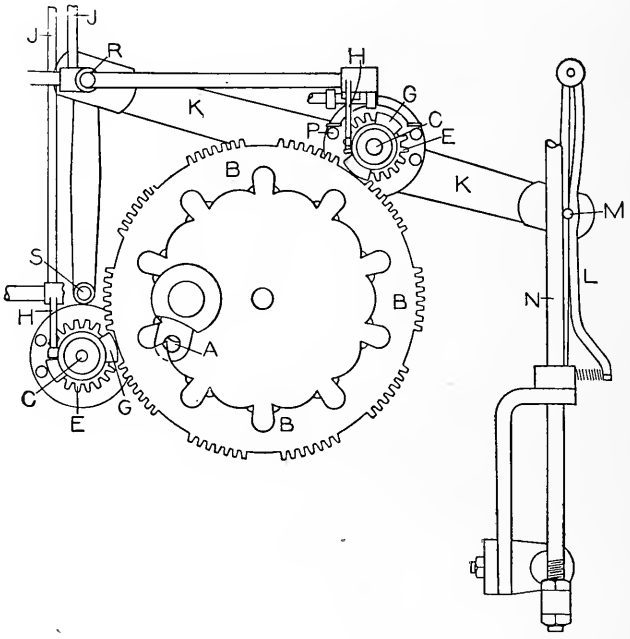


Fig. 117. Lower Box Motion.

advancement of one space has the value of seven teeth. The segment gear revolves on a stud fixed to the frame, about $3\frac{1}{2}$ inches forward of the pick cam shaft. At the top and side of the segment gear, small shafts, C C, are placed, carrying at one end cams, which operate the box lever. The cam on top lifts one box, and the side cam lifts two. A small segment gear, E, having two spaces, separating as many segments of six teeth each, is also fitted on each shaft, together with a double fork or slide, F, which has a projection, G, on each side. These projections are of such form as to fill the spaces in the small segment gear, and

act the part of a broad tooth, meshing with the spaces in the large segment gear.

One side of the slide is twice as long as the other, and consequently when one projection is filling a space on the gear, the other is out of connection; the short end being the starter or raiser, and the long end the returner. Each slide is operated by a small elbow lever, H, which is connected by the connecting rod, J,

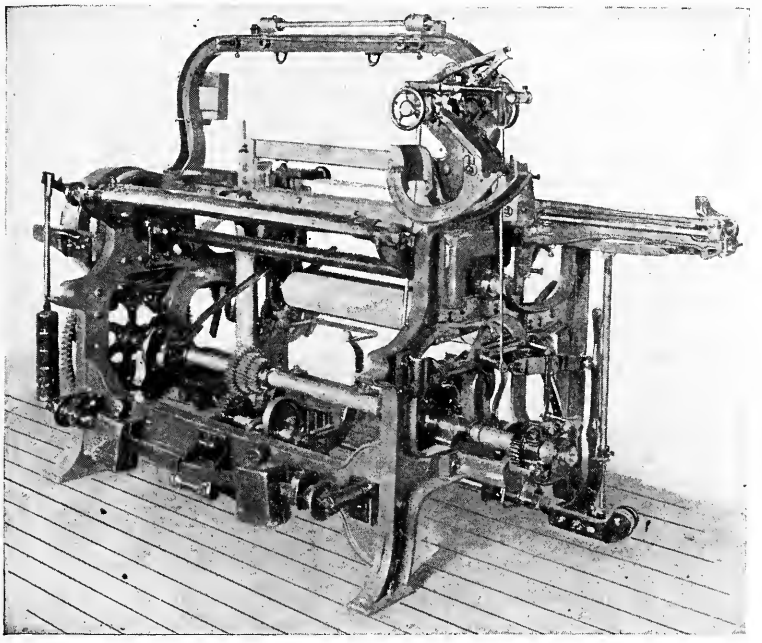


Fig. 118. Crompton Gingham Loom.

to one of the small levers in the upper motion under which the risers in the chain pass. The flat portion of the projection, when in the small segment gear, almost touches the teeth of the large segment gear, so that the projection catches when the small segment gear is turned, and the teeth of both large and small segment gears are brought into mesh. There is but one box lever required with this motion, and this is shown at K, with the spring clamp, L, gripping a stud fixed to its outer end. The lower end of the clamp is attached to the bottom of the box lifting rod, N.

A small finger called the check finger, is provided to hold each cam in place, being held in contact with the small studs by means of a spiral spring.

The normal position of the motion is with the short ends of both slides nearest the larger gear, and when a riser lifts the connecting rod, the small elbow lever presses in the slide until the

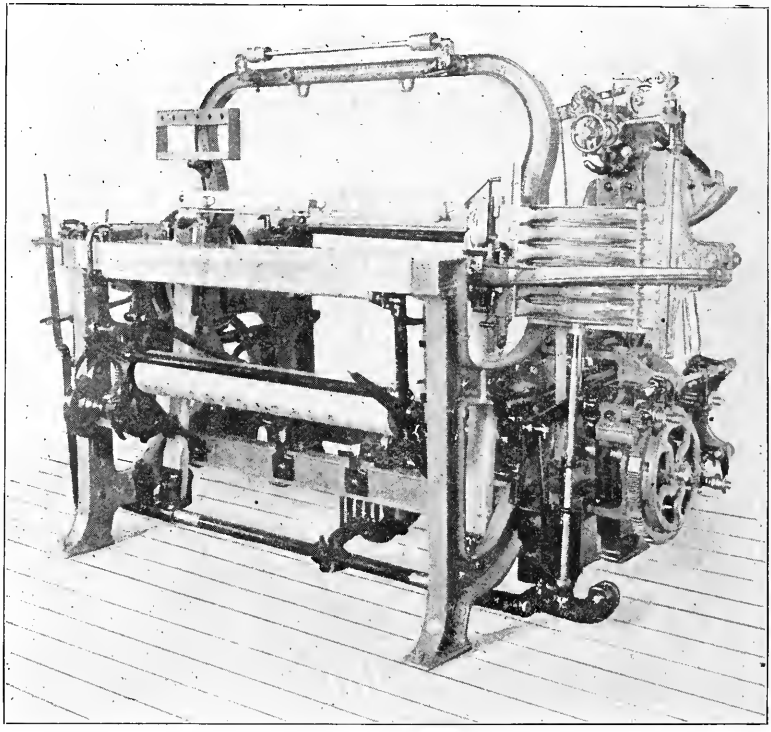


Fig. 119. Crompton Gingham Loom.

projection fills up the blank space on the gear. Then as the segment gear is advanced by the pin gear, the teeth engage with those of the small segment gear, turning it half around, and consequently the cam at the end of the shaft will be given a half turn, thus lifting the boxes. Actuating the top cam lifts one box, and the bottom cam lifts two, or both together lift three. The small gear being turned one-half revolution, the long side of the slide is now next the segment gear. To cause the box to change back again a

sinker is brought up under the top lever, allowing the connecting rod to fall, thus drawing the projection on the long slide into place, and completing the revolution of small gear, when the boxes will return to their normal position. The spring clamp, L, serves the purpose of a protection device to prevent breakage of boxes or shuttles in case of a shuttle or picker binding in the boxes. When the boxes catch, the stud on the box lever is forced out of connection, and slides up the crank, thus preventing the lifting rod from being raised.

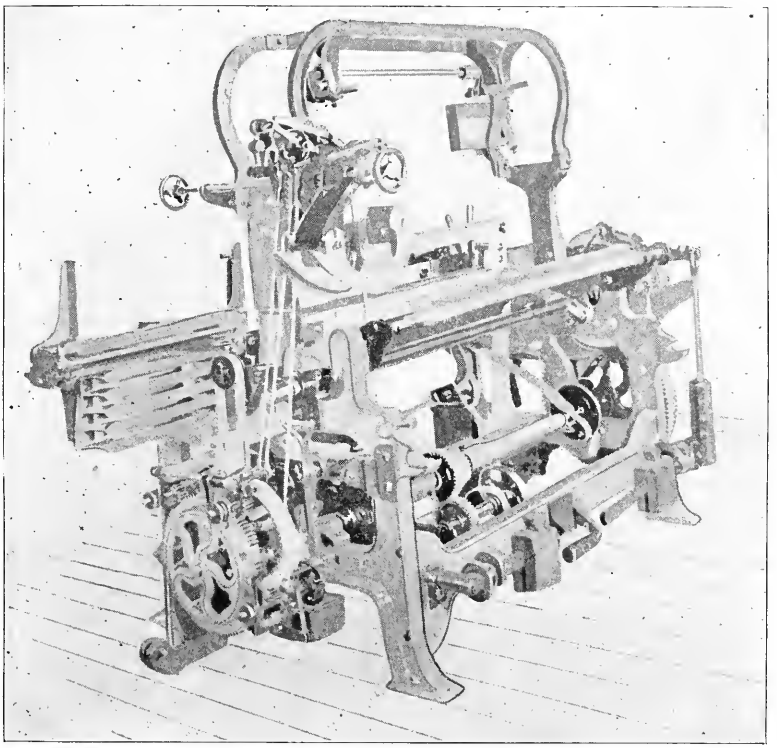


Fig. 120. Crompton Gingham Loom.

Timing and Fixing of the Motion. To time the motion set the pin gear with the pin on the bottom center when the crank is on the back center and the shuttles being picked from the box side; or with the pin on the top center when the crank is on the back center with the shuttle being picked from the single box.

When this box motion is fitted to some other make of loom, the stud which supports the large segment gear is often below the center of the pick cam shaft, in which case the timing must be changed to suit requirements. Set the pin on the top center with the crank shaft on the top center and the shuttle at the box end.

Set the head motion driving cams with the small cam on the bottom center, when the crank shaft is just behind the bottom center coming forward, and the shuttle is in the single box. As the single box lever used with this motion must necessarily supply both single and compound leverage two fulcrums are required, the upper cam serving as one, and the stud upon which the inner end of the box lever is pivoted, acting as the other. This being the case, it is impossible to change the position of the stud at either end of the lever, without affecting the leverage at the other end. For example, suppose the first box is set level with the race-plate, but on raising the second box, it is found to be too low. Moving out the stud, M, would obviate this, but it is probable that the lift would be excessive for the third box, and not only that, but the first box would be too low when returned to normal position. Under such conditions, the only satisfactory method of setting this motion is to work in between the two points of leverage. Starting first with the studs, M and R, near the centers of their respective slots, with M inclined to the outer end, move out S and its connection almost to the limit, and let it remain in this position, because the slightest change at this point makes a great difference in the lift of the boxes. Moving out stud, S, causes the boxes to be lower when normal, but to raise higher when turning the bottom cam. Moving in stud, R, has a similar effect, while setting in stud, M, closer causes the boxes to be higher in their normal position and lower when raised.

In connection with some box motions, the boxes are found to be higher or lower, according to the position of the lay. This occurs to the greatest extent where a box motion is fitted to a different make of loom, but will never occur if the lifting rod and connections are set to move in the same arc as the lay. When the boxes do change position, great care must be used in setting them; the best method being to have the boxes a trifle high when the

crank is on the top center, as this allows for a slight drop as the lay swings back.

The greatest cause of trouble on this motion is the loosening of the small segment gear, and this will seldom occur if due care is used in fitting the gear on the shaft, and in fixing the motion afterwards. Trouble of this sort is met with most frequently on the old type of motion, which is fitted with a check cam to prevent the motion from turning too far. It is the jarring of the cam against the check finger which is the objectionable feature, as the sudden check must sooner or later wear the check cam and loosen both the box cam and the gear.

This motion is not hard to fix if thought is devoted to it, and once thoroughly fixed it will remain in good condition for months. If the small gear should become loose, care must be used in replacing the worn pin, for with a small shaft sprung, the condition is worse than with a loose gear, due to the binding in the bearings, which is difficult to remedy.

The small shaft, C, is a pivot or swivel bearing attached by a pin to the framework of the motion, a spring bolt keeping the bearing in place during the ordinary running of the motion. When anything becomes fast between the two gears, or the teeth of the small segment do not mesh with the teeth of the large segment, the spring bolt allows the bearing to be pressed out of position, thereby separating the two gears and preventing breakage. Occasionally the spring bolt becomes loose, allowing the small gear to work out of mesh with the large gear, and in this way causing a mispick or skipping of the boxes. Sometimes under these conditions the small gear skips one tooth, only meshing with the second tooth of the large gear.

Worn projections on the fork-slides also cause skipping, because instead of the projection engaging with the first tooth of the space gear, the slide springs out. Both slides are alike, but as they work in opposite directions they become worn on opposite sides, and therefore may be interchanged when worn, giving results as good as new ones.

A washer is placed at the end of the single cam to prevent the box lever from slipping, and this washer becoming loose will sometimes bind on the shaft and thus cause skipping. If it

becomes very troublesome remove it, and nothing serious will occur if the motion is set in correct alignment.

Incorrect timing of the chain barrel, bent chain bars, or broken risers, all have the effect of preventing the fork slide from moving into place, and skipping is the result. Chain links riding on the chain barrel also cause skipping. Insufficient lubrication of the shaft, C, the chain lever studs, or the finger rod bearing, will prevent the slide from returning to place when the boxes are to be lowered. A small coil spring placed around the bearing of the finger rod in contact with the finger will help to draw in the slide. The hook to which the check finger spring is attached, works loose occasionally, and allows the small gear to turn a trifle too far. This may cause one of several effects, such as the boxes lifting too high or dropping too low, the picker to become fast in the boxes, or the teeth of the small gear will not mesh with those of the large gear. Binding of the boxes in the slides tends to injure the motion owing to the increased amount of pressure to which the gears are subjected. The stud, M, soon wears out if not sufficiently oiled, necessitating constant fixing of the boxes, as the stud becoming worn allows the boxes to drop lower than they should. It is seldom that the pin in the pin gear requires attention. If the large segment gear shows a tendency to travel too far after the pin gear has left it, the probable cause is a worn supporting stud.

This form of box motion is one of the best and most compactly built, and is adaptable to either slow or fast speed. The parts are substantial, and if the motion is kept well oiled and carefully fixed, it will probably require fewer repairs than any other box motion.

TEMPLES.

Temples are for the purpose of keeping the cloth stretched as near as possible to the reed width during the weaving process. As much care should be used in setting the temples as is used in setting the pick-motion, because unless the cloth is kept approximately to the width of the warp in the reed the edges will not weave as they should. A very slight twist on the temple or a little too much distance from the fell of the cloth is often the

cause of great loss of time. Temples are made for almost every kind of cloth woven, and the kind of cloth to be woven should always be considered when purchasing temples.

Temples may be divided into two distinct types, *burr* or *roller temples* and *ring temples*, each of these types being again sub-

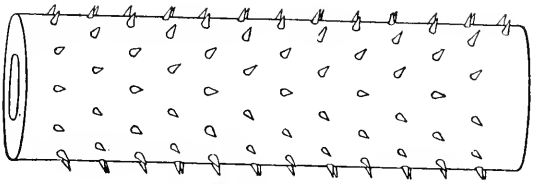


Fig. 121. Burr.

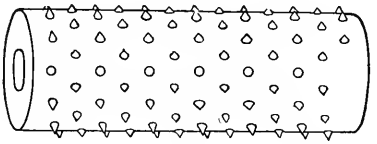


Fig. 122. Burr.

divided into several varieties. The burrs are made of brass, steel and wood, the latter being the most common, and they are fitted with teeth or pins, set spirally around the roller, varying in number and height of setting. Singly the burrs are from $1\frac{1}{2}$ inches to $2\frac{1}{2}$ inches long, but often two or three of the smaller ones are used together, and they vary in diameter from $\frac{1}{2}$ inch to $\frac{11}{16}$ inch, some of them being cylindrical and others tapered. Figs. 121, 122 and 123 show three different burrs to be used for cloth, ranging from fine to moderately heavy cotton or silk cloth. Fig. 124 shows a left-hand temple fitted to the breast beam. It is a spring temple and one of the best possible for general work. A hinge temple is shown at Fig. 125. The burrs and pods or troughs in which they work are similar to those in Fig. 124, the difference being in the position in which they are fixed. Spring temples are probably the

best because of the greater ease of adjustment. Figs. 126, 127, 128 and 129 show four different varieties of inclined ring temples. Fig. 126 is a combined right-hand temple. Fig. 127 shows roll with rings attached. This temple is suited for heavy weight

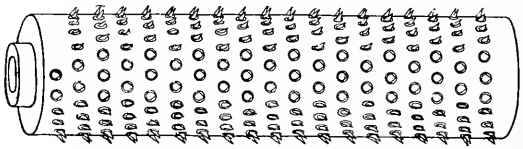


Fig. 123. Burr.

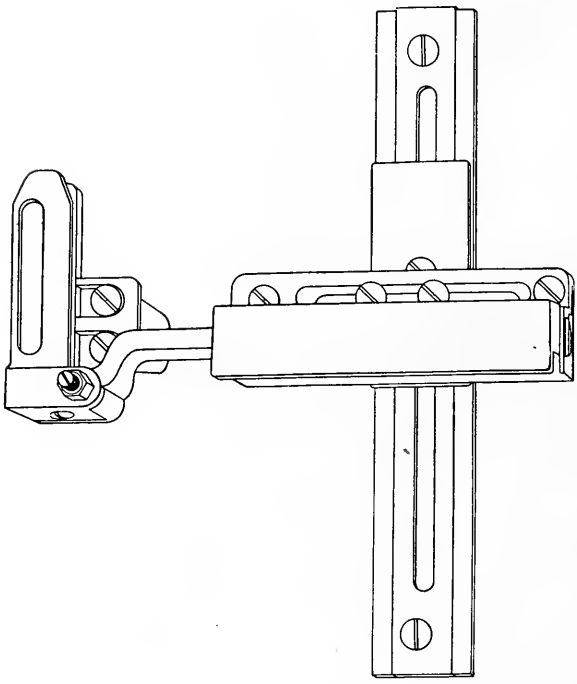
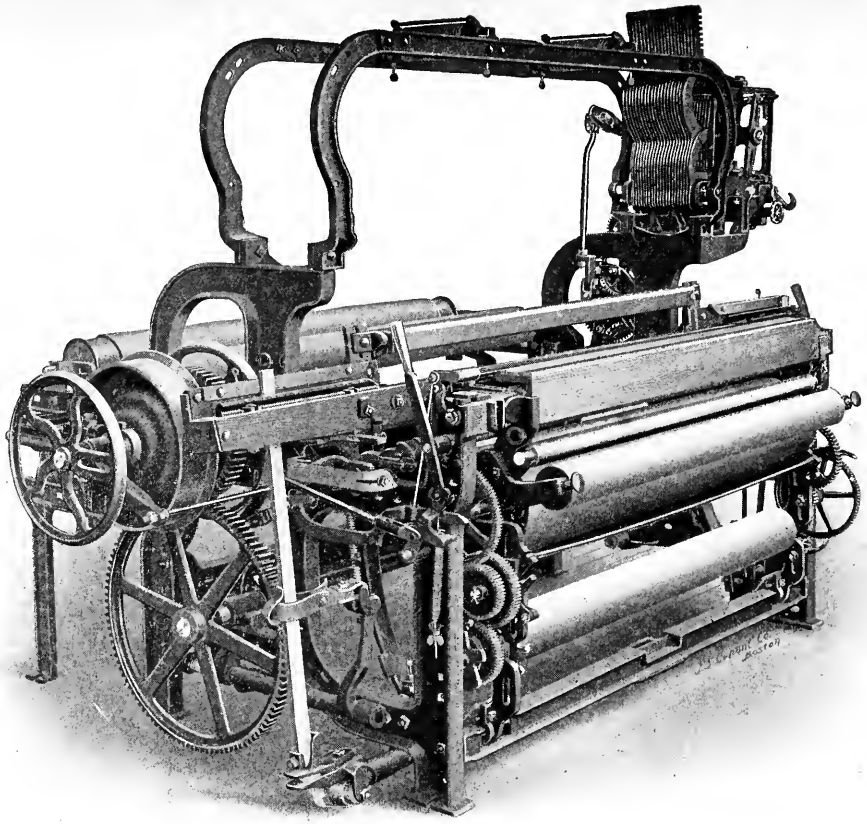


Fig. 124. Left-hand Temple.

cotton goods and light weight worsteds. Figs. 128 and 129 show temples suitable for heavy woolens and worsteds. Ring temples are made from two to fifteen rings, the number being determined



SILK LOOM WITH 20-HARNESS DOBBY

The Geo. W. Stafford Co,

by the weight of the fabric to be woven. The horizontal ring temple, which is illustrated at Fig. 130, is used exclusively for fabrics which must be gripped only on the selvedge.

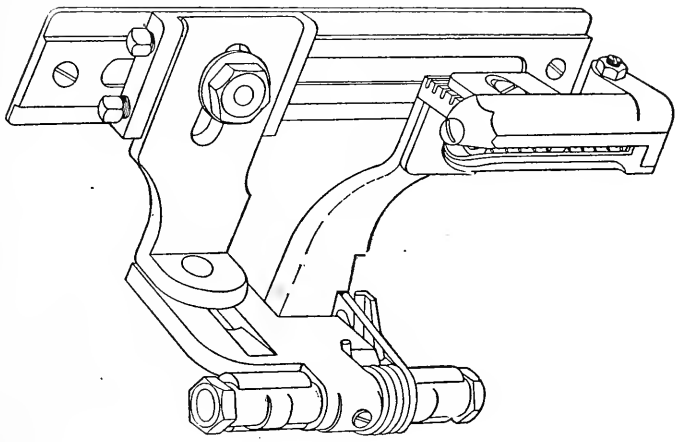


Fig. 125. Hinge Temple.

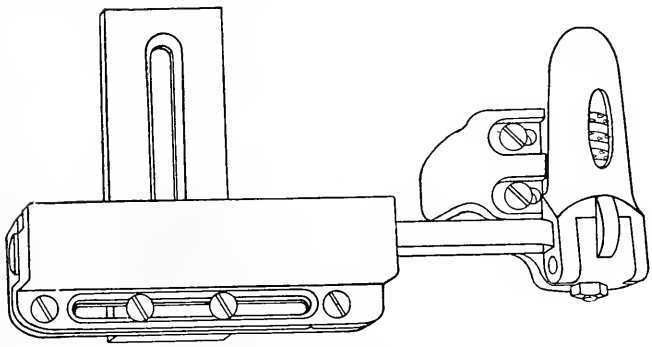


Fig. 126. Combined Right-hand Temple.

As previously stated, temples are to maintain the fell of the cloth at the same width as the warp in the reed, and in doing this temple marks often result, *i. e.*, holes are made in the cloth by the pins in the temple. Every precaution should be taken to avoid

such, particularly on fine goods, and it is fine cloth which is most likely to become so injured. Sometimes the finest burrs will make temple marks, in which case tapered burrs should be used, and the pins covered with tissue paper or very thin cloth until only the points show through. Filling is sometimes wound around the burrs

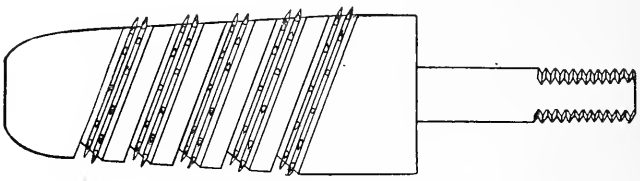


Fig. 127. Inclined Ring Temple.

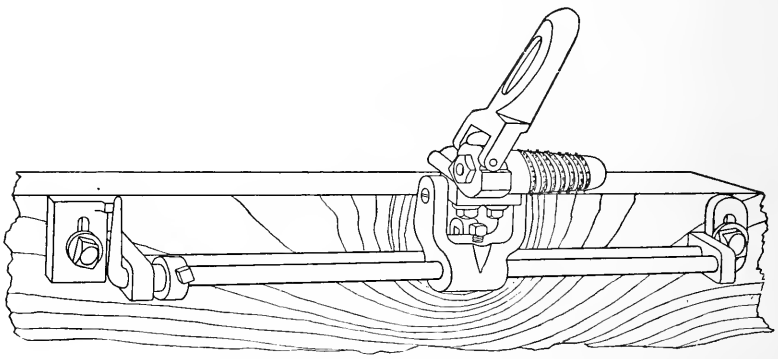


Fig. 128. Inclined Ring Temple.

for the same purpose, but paper or thin cloth is preferable. Using burrs which are too coarse is often the cause of temple marks on fine goods, and finer burrs must be used to remedy any such fault. Blunted or bent pins and incorrect setting are also frequent causes of temple marks. The face of the temple should be set parallel to the fell of the cloth at a distance of from $\frac{1}{16}$ inch to $\frac{1}{4}$ inch according to circumstances. A small amount of action to the temple always has a beneficial effect, especially when it is set close to the fell of the cloth, because it reduces the strain on the selvedge

threads, when the lay beats up. By attaching to the lay sole a piece of leather in such a position that it will strike against the heel of the temple when the lay swings forward, a sufficient amount of motion is given for ordinary requirements.

It is common practice on medium and light weight goods to use burrs for both temples in which the spikes are set in the same direction, the idea being that as long as the spiral turns toward the outer end of the burr they will work as they should. On some grades of cloth this holds true, but it may easily be seen that while the pins point toward the outer end and tend to pull the cloth that way, yet the spiral setting of the pins in both temples is the same, *i. e.*, the spiral setting runs toward the right, and a burr set in this way would act better in a right hand temple with the cloth running over it, because every turn of the spiral would give the pins a closer grip. With such a burr in the left-hand temple the cloth is held by the incline of the pins alone, and the method of setting tends to allow the selvedge to run in, rather than to keep it stretched out. When weaving heavy goods

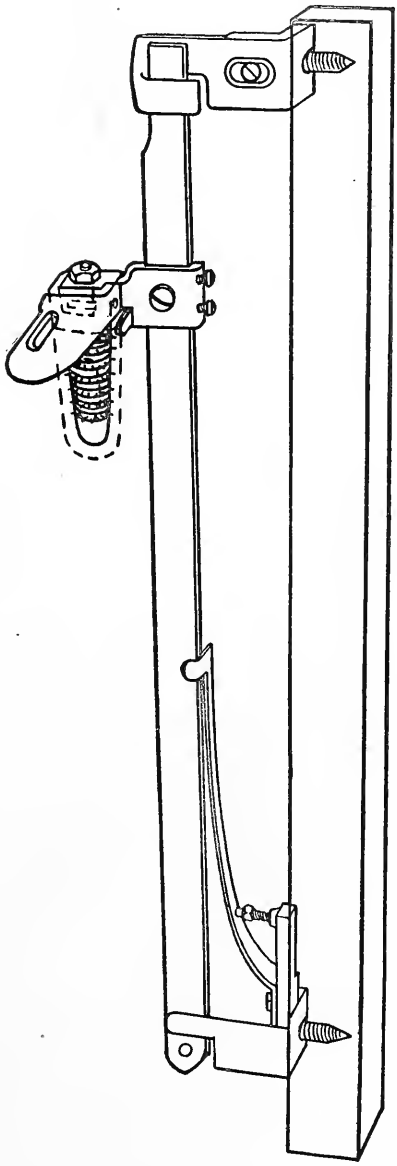


Fig. 129. Temple.

this objectionable tendency of one selvedge to draw in, caused by using temples of the same setting for both sides, becomes more strongly apparent, and that selvedge becoming slack does not weave as it should.

Right and left-hand burrs are now obtainable, and they should be used if the best results are desired. When fitting burrs the spiral setting of the pins must turn toward the right, *i. e.*, like a right-hand screw, for the right-hand temple, and toward the left for the left-hand temple, if the cloth is to be kept at width, for otherwise the cloth will be drawn in.

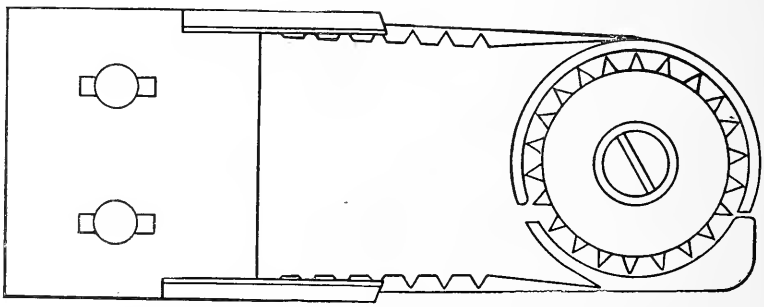


Fig. 130. Horizontal Ring Temple.

The roll in the ring temple may be raised or lowered to change the amount of grip by which it holds the cloth. The higher it is, the firmer grip it has on the cloth, and the lower it is, the weaker grip it has. This method of adjustment allows the temple to be accommodated to various weights of cloth. One of the best ring temples intended to permit of ready adjustment to various grades of goods, is illustrated in Fig. 131. The washer, A, is made with an eccentric ring bearing, upon which the pin ring is placed, and this washer is turned on the stud, C, so as to increase or diminish the length of the pin extending above the washer, thus regulating the contact of the pins with the cloth. The stud, C, is shown carrying the base against which the washers and rings are placed, there being also a solid piece burr tapered on the inner end of the stud.

The Hardaker temple is intended to be used on close shed looms, especially as the temple works with the cloth, thereby pre-

venting injury to the cloth by the temple. On heavy goods there is always considerable movement to the cloth when the lay is beating up, and as it leaves the fell of the cloth. There is also a considearble rise and fall to the cloth, the movement being greatest with the heaviest shed. These temples allow for that movement,

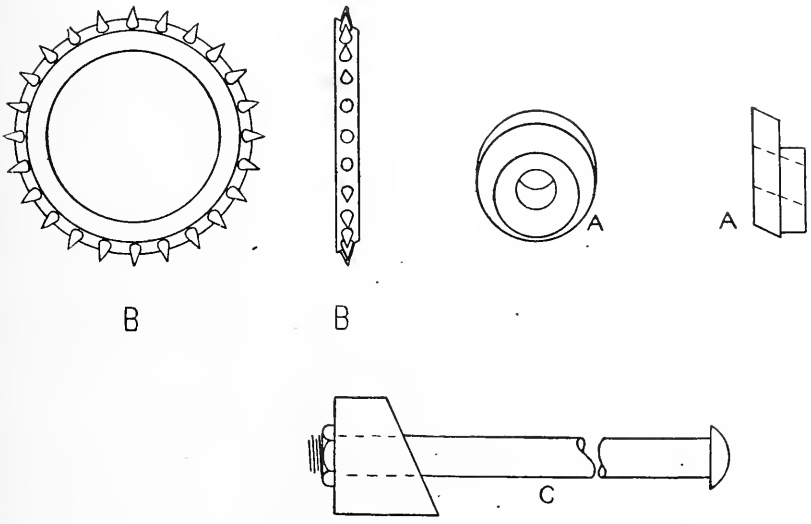


Fig. 131. Ring Temple.

and should be set close to the fell of the cloth, inclined slightly toward the race.

CENTER STOP MOTION.

This type of filling stop motion is usually fitted to woolen and worsted looms, and is of especial value when single picks of certain colors are being woven into the cloth, because the loom will be stopped on the broken pick if the motion is in good order.

The motion is generally fitted to the center of the lay, but on carpet looms two feeler motions are fitted one near each end of the lay sole. It must be kept in the best condition by accurate fixing if good results are to be obtained. A detail drawing of the motion used on the Knowles Broad Loom is shown at Fig. 132. The feeler wires, A, are attached to the base or hub which carries a small crank, B, this being connected through the adjusting rod, C, to the dagger lever, the dagger being attached to the end of this at right angles to it. G is a bracket fixed to the breast beam, having mounted upon it the inclined slide, F, the receiving lever, H, the protection slide, L, and the slide finger, M. The knock-off finger, J, is attached to the rod, K, which extending under the breast beam is in contact with the shipper handle. A flat steel spring, N, is also attached to K, for the purpose of holding M in place when the loom is stopped.

As represented in Fig. 132 the loom is stopped with the lay just forward of the back center, the feeler wires being raised to allow the shuttle to pass under and lay the filling under the wires when the loom is started. When the shipper handle is drawn forward to start the loom, the knock-off finger is raised up under the projection, H′, on the receiver, H, thus causing the upper end to extend above the bracket, G, the lower end being pivoted at H″. As the lay swings forward, the dagger, E, slides down the incline of F, allowing the feelers to drop, and if there is no filling under them they drop into a recess cut in the lay sole. This allows the dagger to drop far enough to strike against the upper end of the receiver, H, and as the lay continues to swing forward, the receiver being pressed down carries with it the knock-off finger, thus, through the connections, stopping the loom. If there is a strand of filling under the feelers, they are held up so that the dagger cannot strike against the receiver, and the loom continues to run. The protection slide, L, acts only on the first pick after each start-up.

Immediately as the loom stops, the flat spring, N, causes the finger, M, to force the slide sufficiently high to protect the receiver from the dagger. When the power is applied by drawing forward the shipper handle, the spring, N, is drawn away from the finger, releasing the pressure on the slide, but the latter remains in place

until the dagger strikes the hook at L′ and forces the slide out of the way, leaving the receiver in position to act. This protection slide is necessary for the reason that often after the loom is stopped, the lay is drawn forward and then pushed back, when the feelers pass under the filling, and if no protection slide were provided the dagger would strike the receiver thus stopping the loom. When no protection slide is fitted, it is necessary to place the filling under the feeler wires in order to prevent the dagger from striking the receiver, thus occasioning a loss of time.

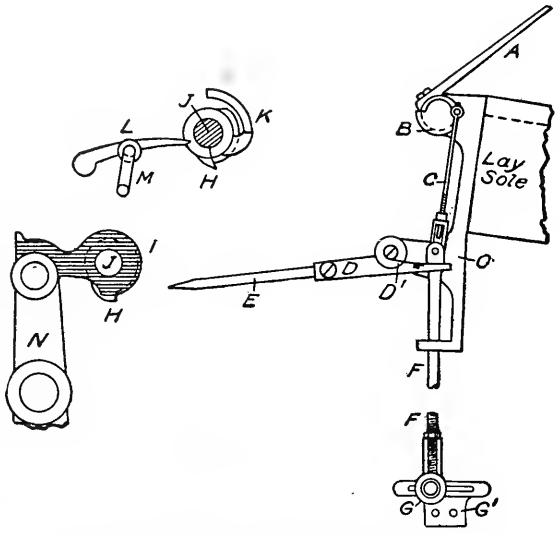


Fig. 132. Knowles Broad Loom Motion.

Timing the Motion. The inclined slide, F, is adjustable to control the action and position of the feeler wires. By lowering the front end and raising the back, the feelers are caused to rise more quickly. On looms fitted with two sets of feelers the slide must be set to raise the feelers as quickly as possible, otherwise the shuttle may strike and bend them. If this happens they are held up by the warp threads, and the loom will not be stopped even if the filling is broken. Adjust the slide, F, and adjusting rod, C, so that the feelers will be raised almost the height of the shed when the crank shaft is between the top and back centers and the dagger is almost at the top of the slide. Set the feelers

in the base so that $\frac{3}{8}$ inch to $\frac{1}{2}$ inch will remain on the filling when the dagger passes the receiver; and yet they should pass clear of the rib of the reed when in the lay sole, to prevent any possibility of the feeler wires catching in case of the yarn dropping to the bottom of the reed. With the lay drawn forward so that the crank is on the bottom center, the dagger should be at the bottom of the slide at $\frac{1}{8}$ inch to $\frac{1}{4}$ inch from the receiver. This range is given to cover a variety of looms. For the Knowles Loom the distance is generally $\frac{1}{4}$ inch, but on the Crompton Loom the dagger should be in contact with the receiver when the crank shaft is on the bottom center, and occasionally with some looms the dagger is set in contact with the receiver when the crank shaft is just behind the bottom center.

On the Knowles Narrow Loom a different form of center stop motion is used. As illustrated in Fig. 132, the motion is composed of the following pieces: A, the feelers; B, feeler cam; C, connecting rod; D, dagger lever; E, dagger; F, adjusting rod; G, adjusting point; G′, bracket; H, receiver; I, lock finger; J, rod upon which lock finger and shield, K, are placed; L, shield finger; M, finger rod; N, locking lever. The adjusting rod, F, is pivoted on an adjustable stud, G, attached to the bracket, G′, which is fitted to the cross-brace of the loom and extending upward through the bracket on the lay sole, the end comes in contact with the dagger lever. It is so adjusted as to push up against the dagger lever, thus raising the feelers as the lay swings back. As the lay swings forward the rod is drawn down, allowing the lever to drop and with it the feelers, so that if there is no filling under the feelers, the dagger is allowed to strike the receiver, H, thus stopping the loom. The locking lever, N, is attached to the brake-rod upon which is also fixed a projection coming in contact with the shipper handle.

When the dagger point strikes the receiver, the lock-finger, I, is raised up, thus releasing the lock lever, and allowing the projection on the brake-rod to force off the shipper handle. If there is a pick of filling under the feelers when they descend, the dagger is held out of contact with the receiver, and the loom continues to run. The shield, K, is controlled by the finger, L, and rod, M, the outer end of the rod being in contact with the shipper handle.

When the loom is stopped the shield covers the receiver, preventing the dagger from striking it, thereby allowing the loom to be turned over by hand, but when the shipper handle is drawn into place, the finger forces up the shield and leaves the receiver free to be acted upon by the dagger. This form of stop motion is one of the most instantaneous in action because, immediately as the dagger strikes the receiver, the power is removed and the brake applied.

In setting this motion have the dagger point in contact with the receiver when the crank shaft is on the bottom center. The feelers are raised to the highest point when the adjusting rod is perpendicular, the crank shaft being between the back and bottom centers. To lessen the lift of the feelers move the adjusting rod pivot farther back in the slot of the bracket, G′, or adjust by changing the screw connection on the lower end of the rod. The former method is the better.

When weaving tender filling if the feelers rest so heavily on it as to break it often, or cause it to kink in the cloth, a small weight may be attached to the back end of the dagger lever at point D′. Or set the feelers so that they will not descend so low into the feeler slot, changing also the timing of the motion to be slightly early, *i. e.*, to have the feelers leave the filling a little sooner than ordinarily would be the case. Occasionally a piece of wire is so inserted in the feeler slot as to come between the feelers and in this way prevent the filling from becoming broken or kinky. General fixing points will be described later.

Odd Points Pertaining to Warps. Under this heading some of the minor problems which come up in running a loom will be considered. A loom ought to be cleaned, oiled, and fixed every time a warp is run out, and if a fixer could only realize how much work a small amount of attention at this time would save him, he would soon make it a regular practice. It is when a loom is empty that some little thing can be seen, which might cause endless trouble when the warp is in. How often a screw head slightly above the race-plate cuts the warp yarn or chips the shuttle a little; or the race-plate is broken behind the feeler-slot, cutting the yarn; and sometimes a flat whip-roll has grooves worn in it which chafe the yarn, when tilting it slightly will remedy the fault.

Accumulation of grease at the box entrance often causes dirty filling, and sometimes causes the shuttle to run crooked, thus making the warp weave badly. Unless the yarn is very poor, a warp seldom weaves badly in a cam loom except in case of the loom being out of order, for which the remedy is given elsewhere. Sufficient attention is not given to the stretch of the yarn from the whip-roll to the harnesses. A warp which otherwise would not run, can often be run out by increasing the distance between the whip-roll and the harnesses. Additional lease rods will often even up the yarn in a warp even though a striped cloth is being woven from the same warp. Double cloths will usually weave better if a lease rod is inserted between the two warps, especially if one cloth is a more open weave than the other, as the take-up differs under such conditions, and the rod should be inserted so that the slack warp is underneath.

The use of a lease rod is also a remedy for rough looking cloth caused by curly warp or filling yarn. Dimities often weave better by the use of an extra lease rod, a wire rod being preferable. A soft warp can be made to run better by laying across the warp a long cloth bag filled with French chalk, or by laying a piece of wax on the warp. The latter remedy is not to be recommended for all cases, however, as any wax retained on the yarn proves detrimental to further processes such as dyeing, etc. A stiffly sized warp may also run better by above treatment, but a damp cloth laid over it, or a pail of hot water placed under it so that the steam will rise and soften the size, will give much better results. Staggering the harnesses is the best possible treatment where a large number of harnesses or heavily sleyed warps are being used. A plaid back can be woven much more easily by adjusting the backing harnesses a trifle lower than the others.

It can readily be seen that if there are six or eight ends in one dent, with the harnesses all level, and four or five of the harnesses on which they are drawn are lifted at one time, those threads will be crowded in the dent, but if the harnesses are staggered the threads will be separated. If when weaving a plain stripe there is a tendency for the threads to cling together, a possible remedy is to use a friction let-off in conjunction with an oscillating whip-roll, fixing the whip-roll so that the yarn is tight on

the center of movement of the harnesses. This prevents the cloth from becoming unduly slack at times, which is the most common cause of threads clinging together. When weaving fine or very thin cloths, there is often much trouble with the filling in the cloth being dragged at the edges, making ragged looking cloth. A piece of wire driven in the top edge of the breast beam will often overcome this fault, but better yet is a roller mounted near the top of the breast beam over which the cloth may pass.

If the fixer will use care in tying in warps, a great amount of yarn may be saved in a year. Tying in warps carelessly is a slovenly practice, and it takes longer to get them started, as well as causing an extra amount of work for the weaver because of some threads, which are not drawn tight enough, being broken out on starting up. First tie in bunches sufficiently large to go under the temple on each side, and then complete the warp by tying in bunches occupying about two inches width in the reed. It will be noticed that the yarn often snarls behind the harnesses, and while it takes some time to draw out the snarls, a bad start-up is the result if it is neglected. When such a case is met with, draw back the warp until the snarls leave the harnesses, and the warp may then be tied in very readily.

The above points are all small things, but they often save hours of labor, and increase the production as well, which is a very material consideration.

CARE OF LOOMS.

Before considering the general fixing of looms, it would be well to understand the following: A loom that is kept in good repair will cause very little trouble, and never serious faults. Looms give warning of coming danger, and the careful fixer will see to it that these warnings are heeded. A fixer who patches a job, very often has serious results from his neglect. A loom banging off, or a shuttle jumping or rattling in the box, is a sure sign that something is giving way; the manner in which a shuttle is weaving, indicates, to the careful thinking fixer, the seat of the trouble, and he knows full well if the warning is unheeded, that probably a shuttle will fly out and hurt some one. If there are any of the parts that control the boxes wearing, the shuttle will

almost invariably show it, because it will be wearing either at the top or bottom. A reed over or underfaced, or bent dents, will show themselves on the shuttle; the back of the shuttle will be worn, or it will be wavy instead of having a smooth back.

The term shuttle flying out, for jumping shuttles and flying shuttles, has been used, because it is a generally accepted term, but there is a difference between the two. A jumping shuttle is one that may skip over the cloth and go in the other box, or it might slip over the end of the loom to the floor, or possibly drop two or three feet from the loom, or the shuttle may jump up from the lay. Such shuttles rarely, if ever, hurt any one, but they are possible indications of a serious defect which, if not attended to as soon as possible, will result in the shuttle flying a good many feet from the loom. By noting distinctly where the shuttle has fallen, and the distance it has gone, it is possible to locate the cause. The shuttle will not travel in the same direction if it meets any obstruction in its passage across the lay, as it will if it has shot clean from the box. A worn picker, picker-stick or loose spindle will throw a shuttle more clearly than any other cause, and these are the two causes that throw the shuttle with the full force of the picking motion; and by a picker springing the picker spindle often adds force to the shuttles. A shuttle that jumps through striking the feeler wires has met a sudden check, and it is impossible for such a shuttle to fly as far, or in near the same direction as when thrown as before stated.

When the boxes are below the race-plate, the shuttle must force itself out of the box, and has an upward tendency. Following out this line of reasoning, the effect can be clearly traced to the cause, and will save many hours of labor.

GENERAL LOOM FIXING.

In these chapters on general loom fixing it is the purpose to give the causes of and remedies for the various faults met with in the majority of looms, whether with cone or bat-wing pick motions, single or multiple boxes. There may be odd cases missed in one chapter, but they will in most cases be found in another; for example, a loose picker will often cause a shuttle to fly out and it

will also cause a loom to bang off. A loose rocker-shaft will cause the loom to bang off and also cause it to be stopped through the filling stop motion. Some of the points have also been explained in the different chapters descriptive of the various parts and motions. Many of the little troubles common to some fixers may be avoided by following the ideas regarding different methods of fixing and the reasons given for such. Special attention should be given to the binders for they are probably the most frequent cause of trouble. Every fixer should have a straight edge, as it is useful for many purposes, particularly for levelling the boxes with the lay or reed.

The various points will be explained in detail in different chapters.

Banging Off. This term is applied to the action of the loom when it is stopped by the dagger striking the receiver, owing to the shuttle not being in place. Various causes are as follows:

Most of the items from 38 to 51 inclusive apply especially to the ball and shoe-pick motion.

Banging off is the most common occurrence in the defective running of a loom, and it is due mainly to changes in the atmosphere although many fixers lose sight of this.

1. Supposing the room to be cold, it naturally acts on the loom, particularly the boxes, so that the shuttle does not run as freely as when it has become warm. The best method to follow is to wipe the boxes and the shuttle with dry waste when in the majority of cases the loom will run all right. It is possible that it may bang off once again, but on starting up it will generally be found that the use of a wrench is unnecessary; and in case of such use changing back again is usually required, when the room becomes warm. Occasionally it is well to apply a drop of oil to the binder, the merest trifle being sufficient. If the loom is damp wipe the boxes and shuttle thoroughly dry, apply a little oil, as above, to the swell, and start up again. Should it bang off again rub the face of the shuttle with some fine sandpaper. It may be noticed that when the box and shuttle are damp the front of the shuttle becomes black from the dampness and friction with the swell. Above points apply only when nothing is broken or worn out, and if it is found necessary afterwards, to make some alterations no loss

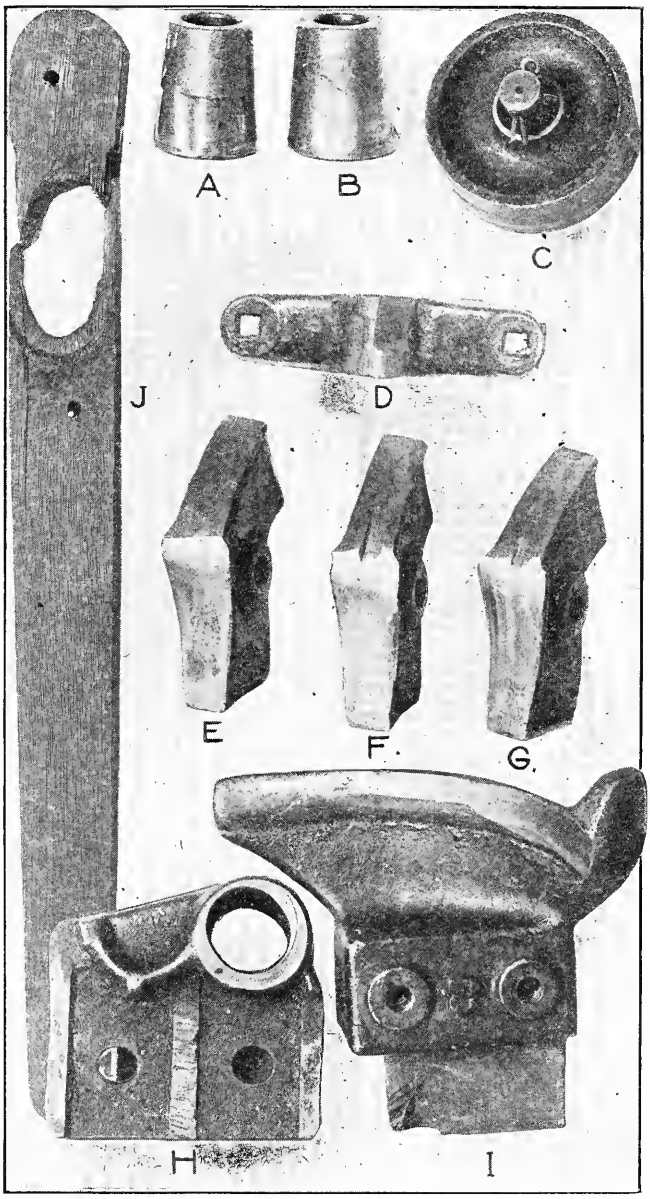


Fig. 133. Worn Parts of Loom Causing Shuttle to Bang Off.

will have been incurred. On the contrary, it is a most beneficial lesson to learn to fix a loom as much as possible without a wrench, because many defects may be remedied in this way and with a great saving in supplies.

2. A loom banging off is sometimes caused by the cone being worn flat on one side. This may be very slight, but very little is sufficient to have this effect. The loom may run well for half an hour, or longer, but as soon as the point of the cam comes in contact with the flat place on the cone a soft pick is the result, and the shuttle not being driven far enough into the box the loom bangs off on the next pick.

3. A partially broken lug-strap has the same effect, because the shuttle is not driven with sufficient force. In repairing the lug-strap, it is advisable to connect the new strap in the same position as the old.

4. The picking-stand becoming worn, particularly the iron projection on it, which fits into the slot of the shoe and guides it, causes the stick to jump because of the shoe catching on it, and the result is either the loom bangs off or the shuttle is thrown out.

5. A worn plug in the picker-stand twists the picker-stick, causing the shuttle to be thrown crookedly. This plug is easily replaced by a new one, and keeping the plug in good condition will save a considerable amount of work.

6. When the pick point of the cam is worn so that the cone slides off out of contact with it, a weak pick is caused and consequent banging off.

7. If the lug-strap has too long a range the shuttle is picked across a little late with the same result. Occasionally, though the shuttle may be picked on time, the sweep or power stick is too short, causing the strap to become soft with a consequent loss of power.

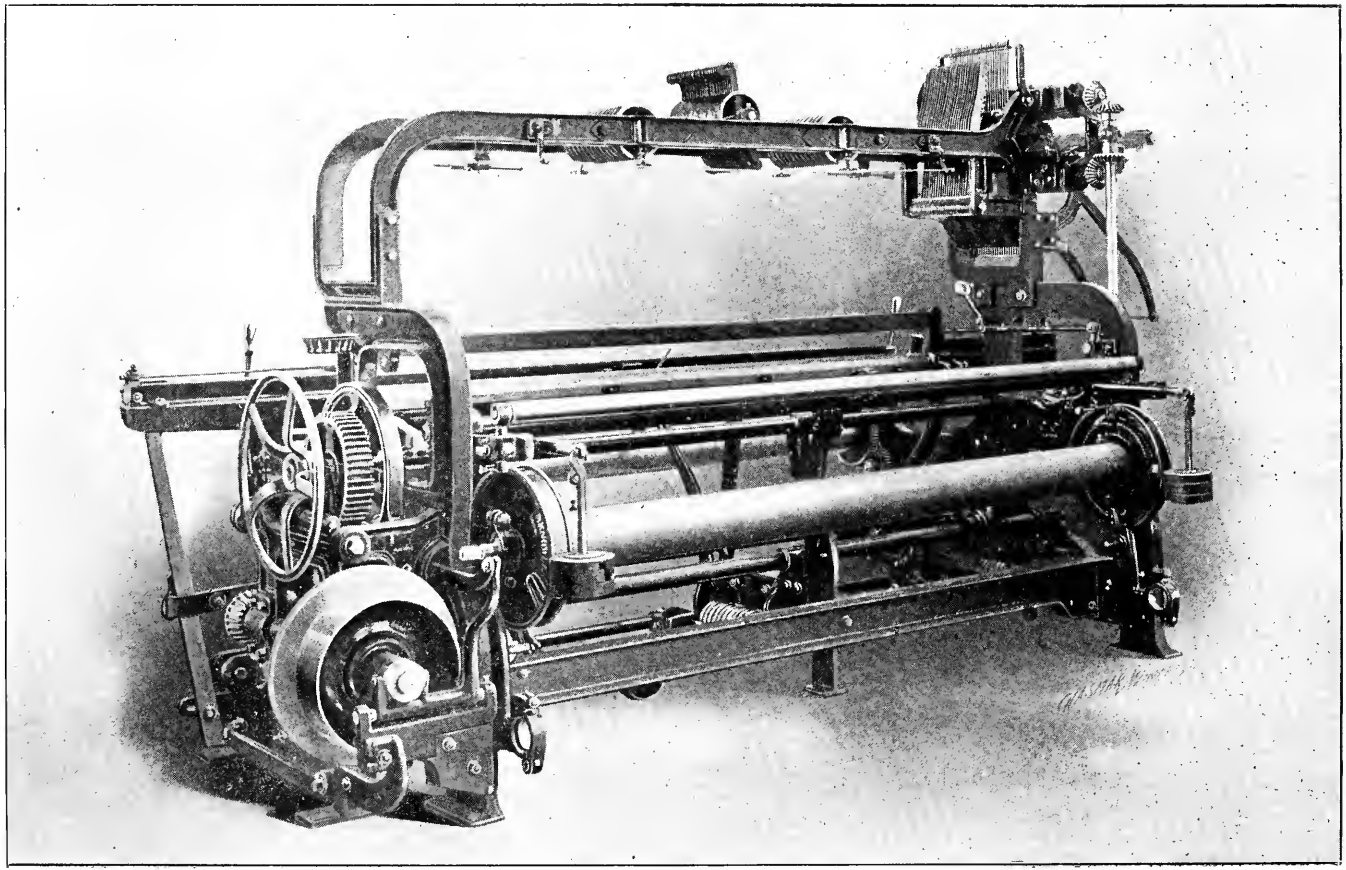
8. A cracked picker-stick is of course lacking in strength, and cannot drive the shuttle with sufficient speed to enter the opposite box, and the loom bangs off.

9. Loosening of the shoe-bolt, which attaches the picker-stick to the shoe, causes either a soft or a hard jarring pick and the loom bangs off on the return.

10. The shuttle striking too forcibly in the box sometimes softens the picker so that there is not the firm throw behind it, and as it does not fully enter the opposite box the loom bangs off. While many fixers discredit this, they often replace the picker.

11. When the collar, which holds the picker on the picker-stick becomes loose, the shuttle may either be thrown out or the loom bang off. The reason for this is that the picker sliding on the stick, reduces the power and keeps the back of the shuttle down, which, by causing it to press against the top of the shed on entering it, retards the passage through. In many instances the collar is loosened by the shuttle rising in the box as it nears the back end, and pushing the picker upwards. This may also occur when the picker-stick is too far into the box instead of being at the back end.

12. One of two conditions is generally responsible for rebounding shuttles; either the pick is too strong, or the binder too loose. As a rebounding shuttle often results in a smash, it is well to use care in ascertaining the cause. By placing the small piece of tube between the extension bolt and the swell, an opportunity is given to watch closely the operation of the loom, and a strong pick is readily perceived. Sometimes it is possible to feel the jar by placing the hand on the lay cap, or if it is seen that the shuttle goes through the shed at the opposite side, clear of the yarn, the strength of the pick may be reduced a little. Do this by lengthening out the lug-strap, or by raising up the stirrup-strap about half an inch, the latter method being preferable. Another method of ascertaining the strength of the pick is to place the hand flat on the top of the box, with the little finger just over the edge of the slot in which the picker-stick moves, known as the picker-race, thus covering the slot to the extent of almost four fingers. If the picker presses sufficiently hard against it to push the hand away, the stick has too strong a pick and too long a range, which may be remedied by letting out the lug-strap. Occasionally the pick-shaft drops slightly and allows the back end of the cone to rest on the cam, in which case a hard pick results. Raising it up again will ease the pick. When the pick is found to be all right, the box pressure must be increased, and this must be done with



KNOWLES INTERMEDIATE LOOM WITH PLAIN LAY

Crompton & Knowles Loom Works

allowances for future changes in speed and atmosphere. A very slight change is usually sufficient, and many times arranging the check-spring at the end of the box will obviate the difficulty. As fixing for present conditions generally necessitates altering back again for the next change, the best method is to fix for average conditions, and thus save time and work.

13. An early or late pick will cause the loom to bang off. The shuttle should commence to move when the crank is on the top center. When the picking motion is late, it may readily be noticed by watching the shuttle as it leaves the shed to enter the box. The shed closes upon it and the tendency is for the warp to become broken. Test the pick from both sides to see if both sides are a little late. If so, the probable cause is that the driving gears have slipped. Sometimes the key is a little narrower than the key-bed in the shaft, and it is only necessary to fit a new key, or the key may occasionally work loose, requiring only tightening.

14. The late pick is also caused by slipping of the pick cams, particularly in the case where it is late on one side only. For this the only lasting remedy is to either sink the screw into the shaft or use a hardened cup-pointed screw which will bite the shaft. A common occurrence in tightening up set screws, especially in pick-cams, is to twist off the heads. Instead of tightening to this extent, it is better to draw up until it tightens against the shaft, then withdraw a little, tightening up solid after this, when it will hold with as strong a grip as possible.

15. When the shed is too early it closes on the shuttle, and when too late there is not sufficient space for the shuttle to enter, in either case the shuttle being retarded so that it does not fully enter the box. This condition is easily remedied, particularly so when the cams are on an auxiliary shaft, when by simply disengaging the carrier gear the cams can be set to the right time and gear replaced. Set the cams to have the shed full open with the crank on the top center.

16. When the shed is too small the shuttle is retarded all the way across with similar results. With cams constructed on correct principles, and with treadles of proportionate length, this does not often occur; but when it does, it will generally be found that the harnesses can be moved up and down for $\frac{1}{2}$ inch or $\frac{3}{4}$

inch, owing to the fact that the harness straps have not been equally attached. Frequently in remedying this defect the shed is made uneven. Taking up one hole in the strap does not always suffice, as they may not be equally spaced, and particular attention should be given to having them equal. Harnesses last longer when a little play is allowed in attaching, but this should not be enough to alter materially the size of the shed.

17. A loose rocker shaft allows the lay to spring up and interfere with the throw of the shuttle, which is sometimes thrown out by this means, as well as causing the loom to bang off. It is only necessary to tighten the bearing to remedy this defect.

18. In connection with an adjustable swell, the lock-nut working loose allows the bolt to slip back, causing the swell to become loose. When the temper leaves the swell, it becomes loose and the loom bangs off. The bolt which retains the binder in its frame shows the effect very quickly on becoming loose by ripping pieces out of the shuttle.

19. Picker-sticks of poor quality will spring and bend, causing a soft pick, and a new stick is the only remedy. Using cheap picker-sticks is false economy, as good hickory sticks at slightly higher cost last many times longer. Picker-sticks have been known to run for five years, and on high-speeded looms which ran continuously.

20. On some looms, collars are fitted on the end of the pick-cam shaft to prevent the shaft from slipping, and if a collar loosens, the shaft will move when the pick is taking place, allowing the cam to leave the cone, with the result of either a soft or a hard jarring pick.

21. Key of driving gears too narrow. Covered under 13.

22. Broken heel-straps allow the sticks to jump, and as the stick does not return to place more power is required behind the shuttle to drive it to the end of the box.

23. A loose or weak spring has the same effect.

24. When the reed is not level with the back of the box it is known as an over-faced reed, when in front of its correct position, and an under-faced reed when behind. The shuttle is caused to run crookedly in either case, and more power is

required to drive a shuttle crookedly because being turned out of its course it strikes the front of the box. A few minutes spent in setting the reed level with the back of the box will save many hours of fixing, as well as adding greatly to the time the shuttle will last. If the reed is over-faced or under-faced it is easily detected through small pieces being chipped out of the shuttle. Single wires in the reed becoming bent forward will also cause the shuttle to run crookedly, and in time the shuttle wears them so that they become sharp and cut the yarn, especially the filling, when the lay beats up. This is one of the causes of stitching. The back of the shuttle becomes worn wavy by these dents.

25. A tight lug-strap binds the picker-stick, thus causing the stick to jump when motion is imparted to it, and the shuttle is driven crookedly, with the usual result that it is stopped before fully entering the box.

26. When the warp is held under too much tension the shed is drawn together, leaving insufficient space for the shuttle to pass through, and the loom bangs off, or it sometimes causes a smash.

27. The bottom of the box at the entrance should be level with the race-plate. If it is too high, the shuttle strikes against it and is thrown against the top; while if too low, the shuttle strikes against the top of the box and there is too little space for it to enter. Either fault will cause the loom to bang off by preventing the shuttle from entering the box, and will also splinter the shuttles, making them so rough that they will constantly break out the warp. When the boxes are not level with the race-plate it is best to look for the cause, rather than immediately alter the position of the lifting rod or chain connections. Sometimes only one box is out of position, and any alteration of the lifting rod or chain would affect all the boxes, making the trouble worse. If the collar on the lifting rod slips a trifle it allows the bottom of the chain-bolt to drop, and the bracket and the boxes are lifted too high. A chain pulley-stud becoming worn allows the boxes to be too low. One or two links of the lifting chain being worn will cause one or two boxes to be too low without affecting the others. To remedy this a thin piece of wire may be attached to the under part of the link, thus lifting

the boxes slightly higher when that link passes over the pulley. Other causes of single boxes being out of position are: the lever which lifts that special box having slipped, and the chain twisting and riding on the edge of the pulley or dropping from the large to the small pulley.

28. Yarn clinging in the shed hinders the shuttle from passing through freely. It may be the result of poor sizing, incorrect timing of the shed, or too small a shed, the remedies for which are manifest.

29. In connection with fancy looms sometimes a harness drops when the shuttle is passing through the shed, in this way holding the shuttle and causing the loom to bang off. More will be said of this later.

30. A worn face on the friction driving pulley causes the loom to bang off, owing to a slackening of the power, with a resultant soft pick. As the belt sometimes slips it is best to determine just where the fault lies. This may be tested as follows: Remove the shuttle, draw the lay forward until the dagger is almost in the receiver, and then draw on the shipper-handle watching the pulley at the same time. If it stops, the friction is all right, and the fault is with the belt, which may be remedied by cleaning with a piece of card clothing and applying a little belt dressing. Dry slaked lime is one of the best remedies for a greasy friction. but a worn pulley must be replaced. Occasionally the driving pulley becomes just sufficiently loose on the shaft to give an uneven motion on starting up, especially when a heavy pattern is being woven, or one having changes from a light to a heavy lift. This looseness may be hardly perceptible, and yet be sufficient to cause much trouble.

31. If the picker is worn it imparts an uneven motion to the shuttle, and also a soft pick, especially if worn too large around the picker-spindle. Should the hole be too deep in the picker, the shuttle is bound and the boxes will not change freely. A crooked or warped picker will not slide freely in the slot and the shuttle is not driven with enough force.

32. Incorrect timing of the boxes has the effects described under 27. The boxes should be timed according to previous instructions.

33. Looseness of the boxes in the slides not only causes a soft pick, but also is the cause of the shuttle becoming broken and flying out. When the motion is imparted to the picker-stick, instead of the shuttle alone receiving it, the boxes, being loose, are carried forward and the front end is thrown below the race-plate, causing the shuttle to strike the end of the plate.

34. If the boxes bind in the slides they will not move freely and the shuttle being crooked in the box cannot be thrown straight.

35. Worn binder pin and pin-hole.

36. Loose crank-arms.

37. Occasionally one crank-arm will wear out faster than the other without being noticed, or new ones will be slightly unequal and the throw of the lay will consequently be uneven. This causes the loom to bang off. Binding crank-arms have the same effect.

38. Shoes slipping will cause the loom to bang off because of a soft pick, but if they are fixed according to instructions given they will rarely work loose. Unless the shoes are worn, tightening is sufficient to remedy the trouble.

39. Worn shoes have the same effect as loose ones, but the only satisfactory remedy is to fit new ones. A worn shoe oftentimes wears the shaft also, so that the shoe will not fit squarely upon it, and the shaft will also require repairing.

40. Lack of oil causes the pick-ball to bind. This will spoil the ball and stud and the only satisfactory remedy is to replace it.

41. It is impossible to obtain a good picking action if the pick shaft binds, and this is one of the causes of a loom requiring more power when picking from one side than the other. To test the shaft remove the sweep-stick and turn by hand, when any binding will become apparent and the bearings can be set to remedy.

42. When the pick-ball and stud become worn, the best remedy is to replace them with new ones. Fit the stud in the slot of the extension as snugly as possible, with the collar flat against the casting. Lack of attention to this small detail means constant fixing and tightening of the stud, which otherwise would not be required.

43. A worn sweep-stick allows too much play to the lug strap and stick, with a consequent loss of power. The sweep-stick should be riveted at the end to strengthen it. Set the sweep-stick and lug-strap in a direct line from the picking-stick to the picking-arm when the crank shaft is just behind the top center, as it is at this time that the hardest pull comes on the pick motion. Failure to set the sweep-stick in this manner causes the studs in the picking arms to become loose, or if the stud is cast with the arm, tends to break it off, or makes the hole in the sweep-stick longer. It is also a cause of the picking-arm breaking because of being twisted. The sweep-stick and lug-strap should be set as nearly level as possible with the stirrup-strap on the outside of the stick. A leather or rawhide washer should be placed between the split pin in the picking-arm stud and the sweep-stick. Old pickers may be cut up for this purpose. Sometimes a sweep-stick is too long and it comes in contact with the dog as the picking-stick is drawn in. This will not only cause the loom to bang off, but will sometimes throw the shuttle. For looms with from 28 inches to 42 inches reed space, a sweep-stick of 6 inches to 7 inches will be found to give good results.

44. On narrow looms the picking-arm is changeable, being placed in a bracket fixed to the pick-shaft. When these get loose the result is either a soft pick or a hard jarring pick, according to the way they slip. An iron wedge is usually placed between the stick and set screw to prevent undue wearing.

45. When the pick-shaft is loose, it is forced away from the ball and there is a loss of power. Before fixing the picking-arm to the shaft it should be examined, and any rough places filed smooth. It does not pay to tighten up the arm unless it fits squarely on the shaft, as otherwise it soon becomes loose and spoils the shaft.

46. Loose driving pulley.

47. Different weights and sizes of shuttles cannot be used on a loom at the same time, as the power to drive them would have to vary proportionately.

48. Shuttles worn round on the back and bottom are

equally bad, as they cannot be driven straight, and often turn over in crossing the lay.

49. Worn wood pulley.

50. If the binder pin and hole is worn, there will be an uneven pressure on the shuttle, depending upon how the shuttle strikes the binder.

Explanation of Fig. 133 on Page 202.

A and B. Worn picking cones.
C. Worn picking ball.
D. Worn knob or pick shaft point.
E, F, and G. Worn pick points.
H. Worn bearing for bottom shaft.
I. Worn shoe.
J. Worn power-stick.

Shuttle Flying Out. A number of the causes of the loom banging off are also the cause of the shuttle flying out, so that in this section when the same cause occurs, reference to those points will be made by number and the explanation can be found in the previous chapter.

4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16, 17, 19, 22, 24, 25, 26, 27, 28, 29, 32, 33, 34, 48.

50. Also, worn picking stick.
51. Worn shuttle.
52. Loose top shed.
53. Bottom shed too high off the race-plate.
54. Worn spindle-stud.
55. Yarn clinging together in the shed.
56. Race-plate loose.
57. Feelers too low in the shed.
58. Shuttle spindle-pin working through the back of the shuttle.
59. Harness spring broken or weak, not pulling the harness low enough for the yarn to be on the race-plate.
60. Loose crank-arms.

Reed over and under faced, that is, in some way the reed has become bent so that it is forward from the level of the back of the box. This causes the shuttle to strike against that part, be it ever so little, and the nose of the shuttle is turned out from the reed. The way to straighten this is to have a flat piece of iron held

against the back of the reed, and straighten the end of the reed with a flat-faced hammer, also assist the reed by softening the pitch that is around the casing of the reed, and in this manner they can often be returned to a straight position, but if the whole reed is out of square, then it would have to be trued up, and sometimes this can be done by altering the lay cap. If the reed being over faced does not throw the shuttle out, it has a tendency to spoil the shuttle by splintering it at the back where it first comes in contact with the reed, and this often breaks the yarn out, because when the weaver is placing the shuttle in the box it is apt to be turned a little causing the splintered portion to rub against the yarn. A loose picker will cause the shuttle to fly out, because the picker slides on the stick to any position the shuttle forces it, and when the stick is at the end of the stroke, instead of the shuttle being slightly elevated at the back, it is down on the race-plate, and the top of the hole of the picker strikes the tip of the shuttle, and the nose of the shuttle is raised up, consequently it will usually fly out.

Another cause is the shed opening too late and there is not sufficient space for the shuttle to enter it, the result is either the shuttle is thrown out on the first pick, or it is retarded so much that it does not go far enough in the box at the opposite side, but still sufficiently to raise up the dagger, and on the next pick the picker strikes the shuttle when the pick is at its quickest time, and in this way the shuttle is often thrown out. The shed closing too soon will also have the same effect as too early a shed.

When that portion of the picking-stick is worn which comes in contact with the picker, it causes a jump to the picker and, consequently jumps the shuttle. It is best to round off the corners of the worn place, or replace with a new stick. Worn shuttle means a shuttle that is round on the back and bottom, such a shuttle will not hug the reed, with the result that it often flies out. If the bottom shed is too high off the race-plate, the shuttle is thrown up as it leaves the box; a similar result occurs from cause 59. A worn spindle stud is the general cause of persons being injured by shuttles flying out. When the stud is worn and the picking-stick works forward, the stud has a tendency to work out from the box, which means that the picker will draw the back end of the shuttle to the back of the box, forcing out the front end of the shuttle.

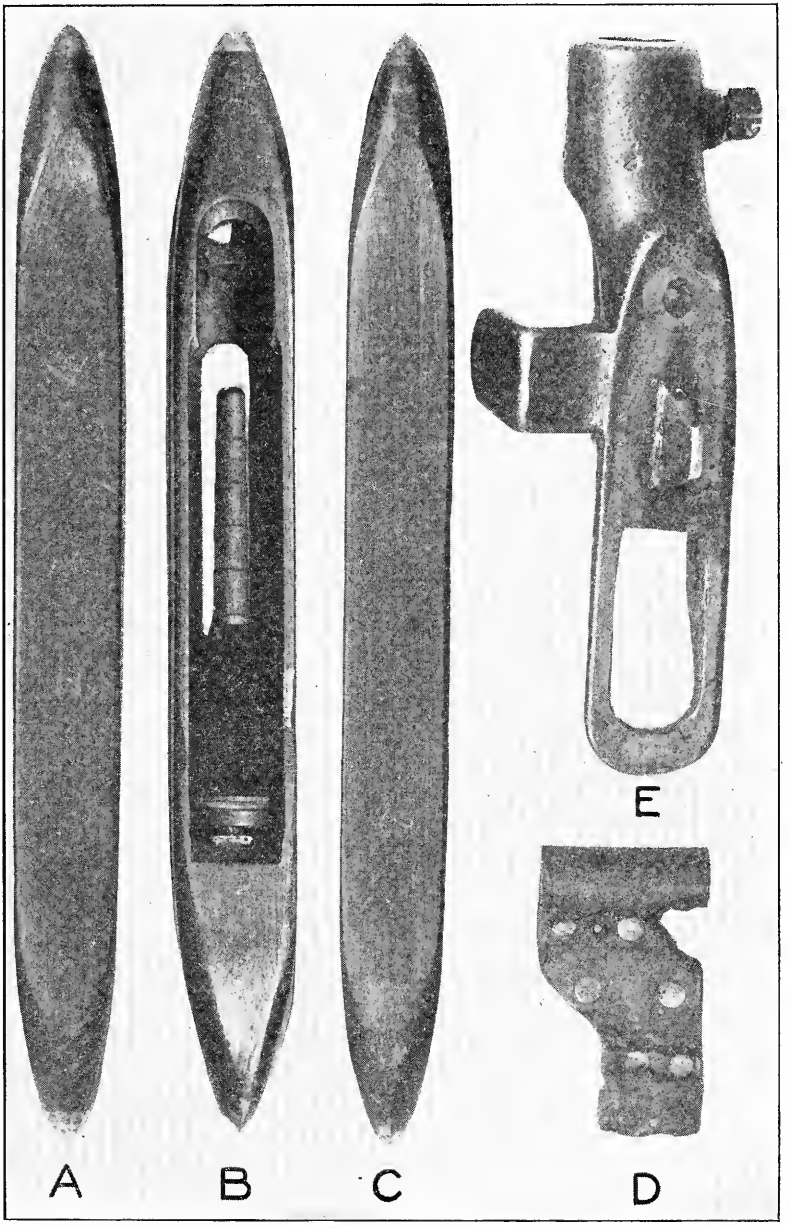


Fig. 134. Worn Parts of Loom Causing Shuttle to Fly Out.

the consequence is, instead of the shuttle being controlled in a measure, it is away from its support and will fly out. A common practice is to pack the worn stud with leather. It is dangerous to fix because the leather has a tendency to become loose after a few picks have been run. Steel cups can be purchased from the loom makers for the purpose of filling in the hole of the worn stud.

Yarn clinging in the shed may be the result of poor sizing, wrong timing of the shed, or too small a shed. Sometimes the race-plate becomes loose in the center, also at the sides, but more often the former, and in nineteen out of every twenty cases the fault is not seen until almost everything else has been done to fix the fault. This is owing to the yarn covering the race-plate. Such a fault will show itself on the shuttle, for the latter will be chipped on the top owing to striking the top of the boxes. If the filling motion feelers are low in the shed, they interfere with the passing of the shuttle across the lay. Sometimes the back of the shuttle will be so much worn that the spindle-pin protrudes and catches the reed. If a harness spring is broken or weak, it will not pull down the harness, so that the yarn is up off the race-plate. This causes the shuttle to run crooked. If the crank-arms are loose, there is an uneven motion to the lay, which causes the shuttle to fly out generally as the crank is passing over the top center.

Explanation of Fig. 134 on Page 213.

A and B. Worn shuttles caused by under or over-faced reed.
C. Worn shuttle caused by boxes being too high or too low.
D. Worn picker.
E. Worn projection on picking stand.

Uneven Cloth; meaning shady cloth and cloth with thick and thin places.

Late or early shed.
Small shed.
Loose rocker shaft bearing.
Odd crank-arms.
Loose crank-arms.
Loose reed.
Uneven shed.
Uneven filling.

Gudgeons or beam spikes bent.
Broken beam flanges.
Worn whip-roll.
Damp friction.
Take-up motion out of order.
Tin or sand roller bearing worn.
Loose perforated tin or tin roller.
Too deep in gear with beam head.
Upright shaft binding.
Worn stud on oscillating lever.
Rough teeth on beam head. } Gear Let off.
Pawl and spring worn.
Spring worn in boss of upright lever.
Oily friction strap.
Worn ratchet.
Rope twisted around the beam head.
Cloth under friction band in a grimy condition.
Friction lever resting on the band or beam head.
Crooked beam head so that it touches the whip-roll when the crooked portion comes round.
Too much pull on the friction cloth roller will strain the cloth, and occasionally causes two teeth to be taken up on the take-up motion.
Uneven setting of the harness.

A number of the above causes suggest the remedy.

Uneven Cloth. This is one of the hardest things to contend with especially in a weave room where the humidity is not under control. The friction let-off naturally feels the effect of the dampness more than the gear let-off, although in some cases the strap that checks somewhat the let-off of the gear is influenced by dampness. The friction let-off is most certainly the best, take it as a whole, that is, the rope wrapped around the beam head, or it may be a chain, an iron band or raw hide. These most certainly give the best results if attended to, but if allowed to go as they please, as the common term is, they are the worst form of let-off. If the rope has become sticky, a little powdered black lead will soon remedy this defect. French chalk is often used, and with good results, but this is more liable than graphite to cake and become sticky with change of atmosphere or if some oil is acciden-

tally dropped on the beam head. There are some fixers who have used oil on the beam head, claiming that it allowed the rope to slip more freely, but the very same fixers have been seen to take great pains in wiping off the oil under other circumstances. It sometimes happens that uneven cloth is caused by the spike or gudgeon in the beam having been sprung; this is caused by banging the beam on the floor, and as the yarn is drawn off, the uneven turn of the beam causes unequal let-off of the yarn.

The take-up motion is often the cause of uneven cloth. The

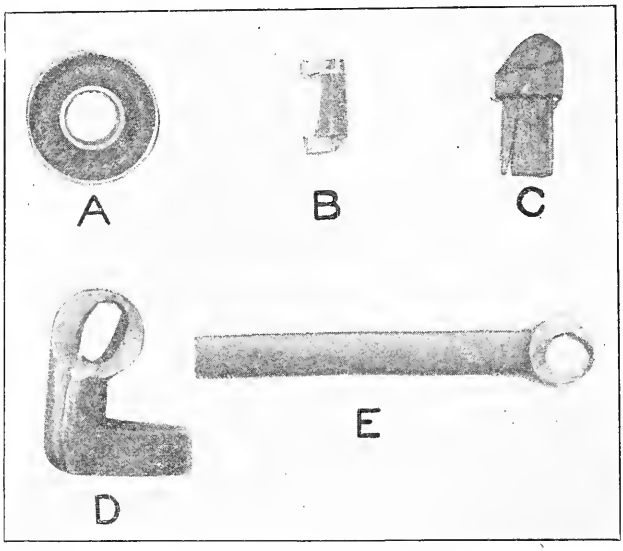


Fig. 135. Worn Parts of Loom Causing Uneven Cloth.

majority of take-up motions that are on the two pick principle, that is, receiving motion from the pick cam shaft, are constructed so that with a little change they can be made to take up two teeth at a time. Under this construction, it is natural then that the ratchet gear has a little play more than what is necessary to take up one tooth, because it is owing to the loss of a portion of a tooth by the check-pawl, and a portion also by the take-up lever that the motion only takes up one tooth. The converging of these points and the using of the loss of space travelled by the take-up lever and

the check-pawl, enables the motion to take up two teeth. If the ratchet gear does not swing a little and work perfectly free, then one can expect an uneven cloth, because instead of swinging back a little to meet the check-pawl, the gear stays in the position to which it is drawn by the take-up lever, and this will occasionally cause two teeth to be taken up. Uneven spun yarn makes a bad looking cloth, and this is sometimes called a cockly cloth. The uneven setting of the harness will cause uneven cloth, that is, the harness not lifting equally at both sides, or an uneven shed, one lifting higher than the other. When using a gear let-off, a fixer cannot be too careful at the first starting up of the warp to see that all is straight, and that the gear which is in contact with the beam head is not too deep in gear. This is one of the most common causes of complaint, because the teeth around the beam head are not always as clean as they might be. Small chips of iron are on the inner edge of the teeth, and if the driving gear is too deep when the beam has been turned to where the rough teeth are, the warp will jump, and, in this way cause these places.

Sometimes the gear is in right pitch with the beam head, and yet thin places are caused; the possibility is that the beam spike is sprung causing an uneven contact with the driving gear. If the stud on which the rod is placed is worn, uneven cloth will be the result, and sometimes the spring that keeps the pawl in contact with the ratchet gear has lost its strength, and occasionally the pawl will slip over the teeth of the ratchet instead of engaging in them. This causes an uneven let-off. This little system of looking before one uses a wrench comes in handy, for by the moving of the small collar, a great difference in the let-off will be the result. On a let-off motion, a spring is often placed in contact with the upright lever. This assists in bringing back the lever and at the same time the pawl; if the spring should slip, uneven cloth is sometimes caused, but not often, as it cannot be called a vital point in the let-off motion. The pawl will sometimes miss turning the ratchet gear owing to the pawl being worn, and this point is often overlooked, the same as the spring. Uneven cloth is often caused by the arm that supports the whip-roll being worn, and if there is much vibration of the whip-roll, this has a tendency to raise a little out of the place that is worn, and if the ends of the

whip-roll are worn unevenly so that if the roll moves around a little, it is raised higher up, consequently uneven cloth will be the result. A round whip-roll is the best if the bearings are kept clean and well oiled; it moves around with the yarn as it is drawn off the beam and there is less possibility of the yarn wearing grooves in the roll, as it often does in what is termed a flat whip-roll, explained more fully under the head of "Construction of a loom."

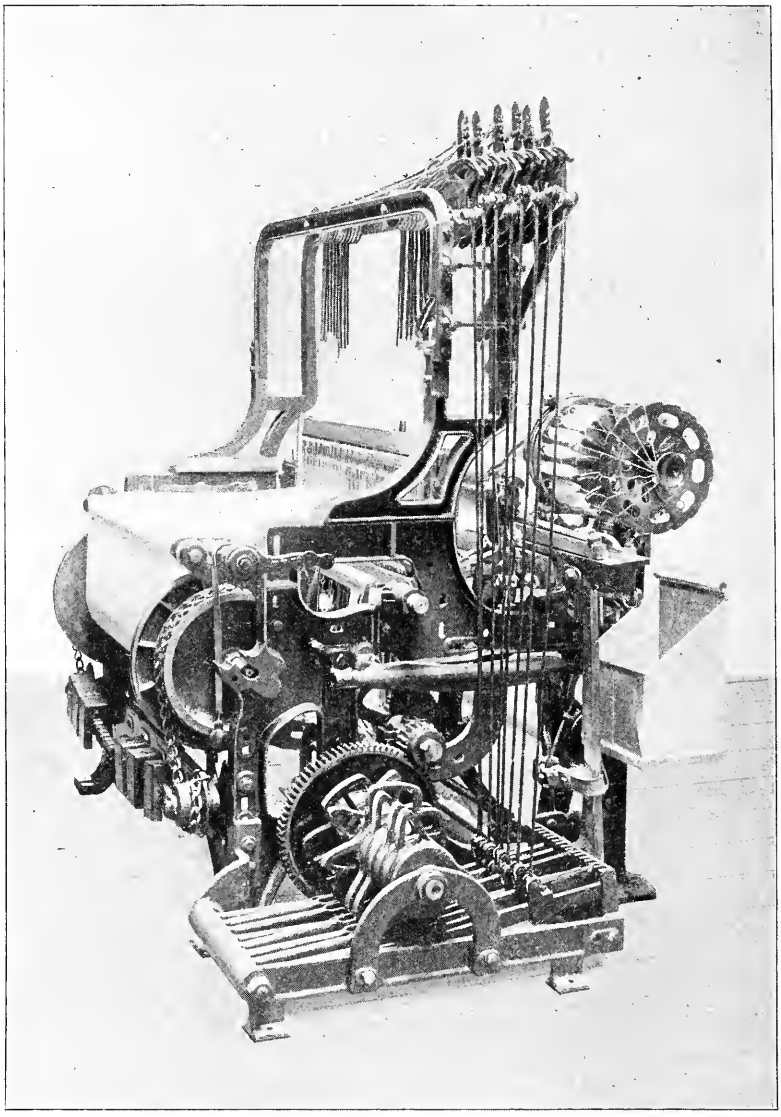
When the rocker shaft bearing is loose, there is an uneven movement to lay when beating up. If the crank-arm is loose, or one is slightly longer than the other, the reed does not beat up evenly; a loose reed gives the same result. If a beam flange is broken, when the heavier side is passing down, it goes down more quickly than when the broken side is passing down, especially is this so when fancy cloths are being woven, and it is not uncommon to add a weight to the broken side to balance the beam. When the bearing for the sand roller is worn, the roller jumps, causing cloudy cloth. Loose perforated tin will sometimes overlap, causing a thin place in the cloth. Occasionally the guide roller will come loose and turn, and if it has not been set straight, uneven cloth will be the result. If the cloth under the friction band is allowed to remain on too long, it becomes sticky, and allows the beam to let off in jumps. Occasionally when attaching the friction, the knot in the cloth is allowed to remain under the friction band and this will cause very uneven let-off. If the friction lever is allowed to rest on the band or beam head, it will prevent the proper letting off of the warp.

Sometimes the weight will touch the floor, or the weight from a top beam touches the lower beam. If the beam head is crooked, when it turns round it will touch the whip-roll. If there is too much pull on the friction cloth roller the cloth will be strained, and it will also occasionally cause two teeth to be taken up on the ratchet gear. If the harnesses are not set level, shady dyed cloth will almost certainly be the result, because the sheds being lower on that side the cloth is a trifle thicker, the consequence is that there is a difference in the absorption of the dye stuff. The center harness connection on the Knowles Loom was designed to overcome this. If one edge of the cloth is slack through the fault of

the temple, shady piece dyed cloth will result. Sometimes there are distinct cracks in the cloth, and in nine cases out of every ten, they are caused by slack yarn, especially is this so with cam work of four or more harnesses. Notice the cloth that is woven and one will see the defects occur almost regularly. Then watch the loom, and the probable cause will be the yarn is slack on one certain harness, and when the filling is beaten up the slack yarn forms in a rub which prevents the close beating up of the filling, raising that harness up a little to tighten the yarn.

Explanation of Fig. 135 on Page 216.

A. Worn link.
B. Worn treadle-pin.
C. Worn treadle-plug.
D. Worn treadle-bowl.
E. Worn connecting rod of let-off motion.



VELVET LOOM WITH SIDE CAMS AND NORTHROP FILLING SUPPLY
Mason Machine Co.

WEAVING.

PART III.

Poor Selvedges and Poor Cloth in General. There is no doubt that a poor selvedge detracts considerably from the value of a piece of cloth, the remark is often made, "Oh that will pass." Not so, there is nothing that looks worse on the counter than a ragged selvedge. It would be surprising to many people to know how much easier it is to sell cloth with a good selvedge than with a poor one. A piece of cloth has been known to pass muster owing to having a good selvedge and yet the body of the cloth has been rough looking through faulty filling. However good the body of the cloth may be, if the selvedge is poor, all looks bad. The sooner the fixers commence to give attention to the making of good salable cloth, the quicker will be the response from the employer to the effect that he recognizes that he has men working for him who are able to think, and plan to turn off the best of cloth and not go about their work in that careless "anything will go" fashion. How is it that there are some mills that have so good a name that a person leaving the place after working there a length of time can work in almost any mill? The reason is, the cloth that is turned out by this mill is first class, and the working people must be in line with such a system or the mill could not have attained the fame it has. There is no reason why any fixer, no matter where he works, should not have the same reputation. If the shed is a trifle too small as the shuttle enters, it has a tendency to twist the outside threads; this defect will make a poor selvedge, also if the shuttle is low at the back as the nose enters the shed, twisted threads will be the result. The wrong timing of the harnesses will cause a poor selvedge. The best time to set the harnesses for almost all cases is to have them level, when the reed is about $1\frac{1}{2}''$ or $1\frac{3}{4}''$ from the cloth on narrow looms. Too large a shed will cause a poor selvedge, as it opens out the yarn too much and

causes the threads to spread out, making an open space between each two. Especially is this shown when a full cop or bobbin is placed on the spindles of the shuttle, and when the filling is near the bottom of the cop or bobbin, the added friction causes the selvedge ends to be drawn in a little, closing up the spaces somewhat between the ends, and a common result from this is that as the yarn passes through the temple, the filling is broken, causing a hole in the selvedge. When there is not sufficient friction on the filling, it is liable to curl up on the selvedge.

The following are a number of ways of inserting friction: The fixing of a small bunch of yarn near the inside end of the eyelet, accomplished by boring a small hole in the shuttle and fixing the bunch of yarn in the hole by a wooden peg. When weaving heavy counts of filling, friction is often added by the use of several stiff bristles. These are fixed to the shuttle, by means of a wooden peg, the hole for the peg being made in the side of the shuttle, so that the bristles will rest on the top of the filling, but near the end. This method can also be used when an extra large cop or extra full bobbin is placed in the shuttle. The pressure of the bristles on the filling prevents it from slipping off in bunches. A baggy shed will cause a poor selvedge, that is a shed where the warp yarn hangs down; and as the filling is laid in the shed, instead of being drawn straight through, it catches on the yarn, and as the pick is beating up the filling curls, makes not only a poor selvedge but a ragged cloth. If the shuttle strikes a little too hard in the box, a poor selvedge is often the result, owing to there being a greater length of filling from shuttle to cloth than there otherwise would be. When adding friction on cop filling, one cannot be too careful, for if the friction is not evenly balanced the filling is generally cut in the selvedge as the cloth passes through the temple, but this will only occur when the filling nears the bottom of the cop, for at this point it lies close to the spindle of the shuttle, and a very little friction is sufficient to make the filling draw off extra tight. The best way at first to add friction to cop filling is to open out the end of the shuttle spindle. This helps to tighten the cop at the nose, and in a number of instances this amount of friction will answer requirements; if it does not, reduce the distance that the spindle

has been spread out and add a little friction to the eyelet of the shuttle, using either a small piece of felt or flannel.

By reducing the spreading out of the spindle, the friction is taken off the bottom of the cop, which can be run almost without friction, and by adding the piece of flannel or felt, you add the friction for the commencement of the cop, the filling occupying a large space as it draws off, and as the cop is reduced in size the filling clings around the spindle, this in a sense takes off the friction that was added by the insertion of the flannel, so that taking both points into consideration considerable trouble will be saved, besides giving better cloth. Often the temple not being perfectly straight, that is, the face of the temple nearest the reed in the line with the fell of the cloth, causes the filling to be broken in the selvedge threads as the cloth passes through the temple. This is caused by the uneven pulling of the burr with the cloth. An extra large shed and uneven shedding will also cause this defect; and keeping the temple firm will cause the filling to be broken.

It would be well to fix a piece of leather to the front of the lay, so that as the lay comes forward to beat up the filling the leather on the lay will come in contact with the lip of the temple, and force the temple back to about $\frac{1}{8}''$ to $\frac{1}{4}''$. This allows a little yielding of the cloth when the reed is in contact with it. The temple can be forced out too far, and the result desired will not be obtained. If the pin that holds the burr in the temple is rusty, holes in the selvedge will be the result. A badly worn burr will sometimes cause the filling to be broken in the selvedge by not having grip enough on the cloth, and when the reed is beating up the filling the yarn has to be spread out so much to be in line with the reed that the filling is broken, especially if there has been too much friction on the bottom of the cop. It is very seldom that this defect occurs in a full shuttle. Sometimes this defect is caused by a late picked shuttle, but only when nearing the bottom of the cop. This is caused by the extra strain on the selvedge as the shuttle forces its way through the selvedge threads; it draws back the cloth at the same time from under the temple. If the filling catches in the box on the picker, or in any way is held instead of passing clear into the shed, as soon as it becomes loose, it is dragged into the shed, forming a thick place. By watching the loom for a short time, this is very soon remedied.

If the warp has been run on a slasher that has had a narrow press roll, however slight it might have been, poor selvedge will be the result; the portion that the press roll does not touch is more loose and occupies a large circumference on the beam, and as the warp is drawn off the threads become slack, and a good selvedge cannot be made with slack yarn. If a warp has been made and the tension has been changed on the spools, it is liable to cause kinky filling, and sometimes when cotton yarn is run with the woolen yarn, if there has been too much friction on the cotton spools, kinky filling will be the result. Woolen yarn stretches more than cotton yarn, and allowance must be made. Whatever kind of warps are being made, if there is more than one kind of yarn in the warp, due allowance must be made for the difference in the stretch of the yarns.

When backed cloths are made and the warp is on one beam, it often happens that the yarn forming the backing cloth becomes loose. To overcome this fault the whip-roll has often to be changed. Raising the whip-roll will make the bottom shed tight and the top shed loose; lowering the roll will have the opposite effect. Closing the shed a trifle earlier will often cure kinky filling, but care must be taken as a return result may be kinky warp yarn, especially if there is a sudden change from a light to heavy lift of harness. If the filling is clear and the warp alone is kinking, often by the changing of the whip-roll, adjusting the weight, and having a late shed, the kinks can be overcome. If the feelers get down in the lay too soon or they rest very heavily on the filling, kinks will result. By adding a small amount of weight to the feeler base, this will be remedied. Often by placing a piece of wire in the feeler slot, so that it will come up between the feelers, kinky filling will be prevented. If filling or warp is kinky, and the shed is being changed to overcome the fault, due consideration must be given to the pattern that is being woven, and the timing of the boxes, for if the whole shell is changed, the timing of the boxes will be changed, and the change being made without thought has been the cause of many breaks. The pattern also makes a difference. If there is a sudden change from a light to a heavy lift of warp, the shed will not close as soon as when even sheds are being lifted, that is, the heavy lift and the light

lift coming together will not have the effect of holding the filling as tight as an even shed will, not until the harnesses have passed each other. The great causes of kinky filling are uneven or too strong a pick, or poor tension on the filling in the shuttle.

Filling Breaking. Bobbins Breaking.

Spindle too small for the cop tube.
Pick too strong.
Loose binder.
Rebounding shuttle.
Boxes too high or too low.
Over and underfaced reed.
Crooked running shuttle.
Worn shuttle.
Bottom shed high off the race-plate.
Temple too high.
Loose crank-arms.
Soft spun bobbins.

Filling Breaking. There is a distinctive difference between filling breaking and filling being cut, or cutting filling. The term "breaking" means if using cop filling, the cop will break on the spindle and will come off in a bunch, and if not caught in time will cause a break; the same with the bobbin, the filling comes off in bunches. With cops there are two or three causes for this. The tube on which the cop is spun may be too large for the shuttle spindle. This can often be overcome by opening out the shuttle spindle at the back, inserting a small piece of leather or tube, but at the same time remember the fact that you can open the spindle out too far, so that when the cop filling has run off near to the bottom, there will be too much drag on the yarn, and the filling will be constantly breaking. This point is often overlooked and it is the cause of a great amount of waste, for in the endeavor to draw the cop down the spindle, when it is three-quarters woven off, the rest of the cop is spoiled and becomes waste. It hardly seems possible sometimes that the cop can be too tight on the spindle, but it can. As a proof of this, how often one sees a weaver when the filling has almost run out, and it has broken, instead of drawing the cop bottom off the spindle, the tube has to be cut off, and when this is done, it must have been stretched considerably, and at the same time the filling has had all the

nature stretched out of it. Sometimes fixers have worked on a loom for what they thought was the filling cut, whereas it was the spindle that was opened out, without due thought for the reason. The filling breaking can be remedied by opening out the point end of the shuttle spindle. If opened too far, it will certainly help to break the filling. For example, suppose the spindle has been opened too far, and the filling has broken, draw down the remainder of the cop nearer to the spindle point, and in nine out of every ten cases, the filling will run off all right. This then shows that there is added strain on the yarn under such circumstances.

Filling can be prevented from breaking off at the shoulder whether cop or bobbin, by the use of a few stiff bristles. These can be inserted in the same manner, as explained, in adding tension to the filling. If the filling breaks lower down than the shoulder on the cop or bobbin, in the majority of cases it is because the pick is too heavy, or possibly the boxes are not tight enough. If it is possible to take off a little pick, by all means do it, for any practical man knows that the reducing of the power of the pick is economy in supplies and labor. If the boxes are not tight enough it is an easy matter to close them in, but be governed by understanding the reason why, because if the box is made the least bit tighter than necessary, when starting up the speed after being stopped for noon hour, or over night, in all probability the loom will bang off. Tighten the box as little as possible. Sometimes the breaking of the filling can be overcome by the alteration of the check spring at the end of the box, so that it will offer a greater resistance to the shuttle. The following question was asked in an examination in Weaving, and the answer to the question may possibly be beneficial to some one:

Supposing you received a quantity of cop filling, the cops being longer than the previous ones that were used, covering almost the entire length of the shuttle spindle, and there is a tendency for this filling to break off, what means would you employ to overcome this difficulty with the least amount of waste, the shuttle being the standard size for the mill, and the spindle being of regulation length? This is the answer: Press down the cop on the spindle as firmly as possible, taking care not to twist it,

take off a little pick, then the shuttle naturally requires less resistance when entering the box, so that by loosening the spring on the binder, the shuttle will enter into the box more freely, yet not with sufficient power to break the filling. Adjust the check spring if necessary, and add a few bristles to the shuttle. This has actually been tried and proved to be all right.

The bobbins in the shuttle are more often split through the shuttle striking the top of the box than from any other cause. The cause may be the bottom shed off the race-plate, boxes changing too soon, or a crooked running shuttle. If the bobbin fits tightly on the spindle and the pick is too strong, broken bobbins will sometimes be the result. The box a trifle low and a small shed or late shed is a cause of shuttle turning; also temple too high.

Filling Being Cut.

Poor shaped swells.
Pick too strong.
Flat faced shuttle.
Sharp eyelet in shuttle.
Flat shuttle.
Box entrance too narrow.
Sharp edges on groove in swell.
Loose picker collar.
Worn projection on picking stand.
Wrong setting of the temples.
Sharp dents in the reed.
Sharp filling fork and grate.
Feelers too heavy for tender filling.
Wrong timing of the filling motion.
Fork resting on the bottom of the lay.
Uneven yarn.
Threads clinging in the shed.
Wrong timing of shed.
Uneven shedding.
Crooked running shuttle.

Cutting Filling. This work often causes a great amount of trouble, especially when mispicks are made either in plain or fancy cloths, particularly in fancy cloths. Take for instance on a leno pattern, and the mispick is towards the center of the cloth, the

sides of the cloth being all right, if this should happen at the crossing pick the pattern is spoiled. The cause of this will be explained later. The causes of filling being cut are numerous. A prevention for the filling being cut in a general sense is a well shaped swell. A bow shaped swell is of no value in any case, for as explained in the fixing of the pick, it requires a great amount of power to drive a shuttle in a box with a bow or blunt shaped swell attached to it, and why some loom makers persist in making these swells is unaccountable. They do, however, and the shuttle has not run half a day before the face around the eyelet has been worn flat, and this is one of the many causes of the filling being cut. The eyelet will become sharp, and then the best method to pursue in repairing it is to make the eyelet smooth with a piece of emery, and drive the eyelet a little further into the shuttle. This will allow the groove in the shuttle to be made a little deeper, which is an essential point in the running of a shuttle.

The blunt shape will not only wear off the groove in the shuttle, but will also cause the shuttle face to chip, and this is often the cause of the filling being cut, besides sometimes cutting the warp threads. If the groove in the face of the shuttle is worn, the filling will most certainly be cut. This causes the filling to be pressed against the swell or the front end of the box and as the shuttle passes in, it will be cut. It is an easy matter to file a deeper and wider groove or have the carpenter plane a groove in the shuttle. A flat shuttle has been known to cut the filling, especially when the groove on the bottom of the shuttle is worn. This is another reason why it is best to elevate the back of the shuttle a little; if it is not elevated, it will rub on the filling as the shuttle passes out of the box. A shuttle that rises slightly in the box, especially if the edges of the groove in the swell are a little sharp, or when using a flat faced swell, the rising shuttle will often cause filling to be cut.

One of the best remedies is to take the swell from the box, place it in the vice and bend it over a little at the top, a very little is sufficient and in the majority of cases this rule will be found to give the desired result; not only does it keep the shuttle down but it prevents the cutting of the filling because the face of the shuttle is clear from the swell. The entrance of the box can be

filed a little at the bottom and this will materially assist in the prevention and it is far preferable to attaching a strip of leather, for the leather soon looks dirty, besides blackening the filling if care is not taken. A small piece of leather can be placed behind the swell at the top, near where it is bolted to the loose part of the box, but it is preferable to bend the swell, for then it is permanent. This will also prevent the soiling of the filling, which when woven in the cloth is hard to wash out. If the entrance of the box is too narrow, a common result is the filling being cut, or the filling becomes soiled at this point, after the shuttle has been run a short time. The least distance that should be allowed extra for the entrance of a box is $\frac{1}{4}''$ wider than the shuttle and it does no harm to have it wider still than this; for by having it so, a better range can be obtained for the shuttle, and better results in every way. If the temple is too low on the race-plate, as the lay comes forward, the filling that is on the plate gets underneath and is cut.

Sometimes the filling is not cut clean, but just hangs together and as soon as the strain of drawing off the cop or bobbin is felt, it breaks, and in all probability the end that is hanging outside the shuttle will catch in the shed at the other side of the cloth, and consequently the loom does not stop and there is a mispick in the body of the cloth. This is often mistaken for a harness missing, but if examined closely it will be found that the filling is cut. The temple being too close to the reed will cause the filling to be cut as readily as the temple being too low on the race-plate, especially is this shown in a loom where almost all the full reed space is used. As the lay is on the front center, the filling is drawn against the temple and consequently in a good many instances it is either partly cut, or cut altogether, and if only partly cut, then mispicks are often the result. This is also another reason why it is advisable to have the lay press back the temple a little. If the grate is sharp, or a groove is worn on the face by the constant working of the loom, occasionally the filling will be cut, but in a number of looms the grate is now being placed back a trifle, for the purpose of preventing the shuttle from rubbing against the face of the grate, and in this way gradually making the edges sharp. If the filling fork passes too far through the grate, there is the possibility of having the filling cut occasionally and especially so if the bottom

of the fork touches the lay, when it should be freely pressed back by the filling. There is no need of having the filling fork pass through the grate any more than is necessary to just raise up the

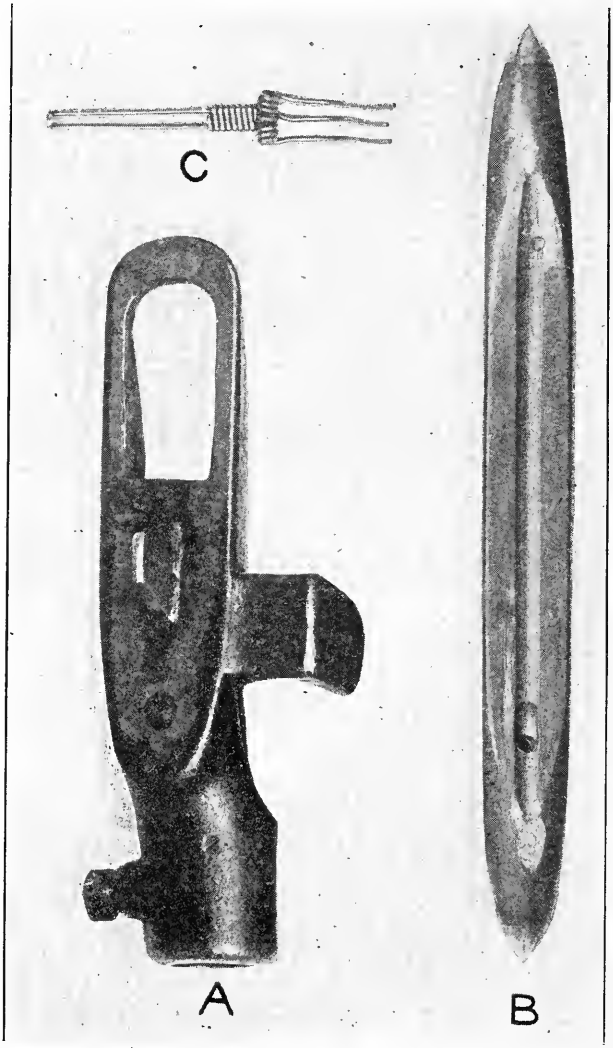


Fig. 136. Worn Parts of Loom Causing Filling to be Cut.

fork from the catch of the elbow lever, when the loom is turned over by hand; because when the loom is running, the filling over the grate coming in contact with the fork at a quicker speed, there

will be sufficient clearance given to the fork. By all means have the bottom of the fork clear the lay. Sometimes the filling will be cut by the wrong timing of the elbow lever, that is, the lever moves too soon so that the filling must force the hook of the fork off the catch of the elbow lever.

It will sometimes happen that one or two of the dents of the reed have become sharp through a faulty place on the shuttle, and when these come in contact with the filling when beating up the last pick, the filling will be cut, especially if there has been considerable friction on it. Of course, this defect will often cut the warp threads, but sometimes it will not, and yet will cut the filling if the temple has been touching the reed. The face of the dents become flat and sharp, and will often cut the filling in the selvedge. If not worn too much, the reed can be remedied in the loom by using a little flour of emery and a flat piece of hard wood, rubbing the edge of the wood on the dents; it is best to add a little oil to the emery, which gives it the form of a paste, so that it can then be used to better advantage. If the shuttles run crooked across the lay and strike the front of the box, cut filling is often the result, especially at the side where the eyelet of the shuttle enters first. The remedies for this have been given. If the rollers in the spinning frame have been dented a little, the result will be uneven yarn. Some parts do not have strength enough to resist the drag as it is placed in the shed and no amount of loom fixing will cure this. Threads clinging in the shed will cut filling. These are often called by the name of twitty places, or stitches and in a heavy warp, especially of worsted, this fault will generally occur. An early and small shed is often the cause; also badly sized and beardy yarn. A little French chalk or wax on the back of the warp will help to overcome the latter. Sometimes even though the warp threads do not cling together, a shed that is very early will cut tender filling.

Explanation of Fig. 136.

A. Worn projection on picking stand.
B. Worn shuttle caused by loose binder bolt.
C. Worn fork.

Loom Stopping, or Failing to Stop When it Should.

Crooked running shuttle.
Wrong timing of the stop motion.
Worn rocker shaft and bearing.
Rebounding shuttle.
Wrong setting of the stop motion.
Dagger rubbing the receiver plate.
Bent connecting rod.
Worn lock lever.
Waste in feeler slot.
Bent feelers.
Late pick.
Feelers too low in the shed.
Rebounding dagger.

If the dagger is worn it will rebound over the catch finger; the dagger should be filed square. If the feelers are bent, they will not drop low enough in the feeler slot, and the dagger passes the receiver. Sometimes the feelers work out a little and catch on the rib of the reed, and the loom will continue to run; or the paper comes loose from the rib of the reed, or if waste is allowed to accumulate in the slot, or occasionally a thread, and remains in the reed, all cause the above result. A late pick will cause the feelers to bend, especially if they are low in the shed. A crooked running shuttle often caused by a worn picker-stick will bend the feelers. If the edge of the lock lever is worn, the shipper will slip off. Sometimes the rod that holds up the slide will become bent, and cause the slide to cover the receiver. The timing of the motions is given in the chapter on filling stop motion. A crooked running shuttle in the majority of cases is the cause of this.

If the shuttle does not enter the box straight, the back end of the shuttle strikes the fork and causes it to rebound, and in the rebound it catches to the end of the elbow lever, and even if the rebound is not perceptible, it is often sufficient for the fork to come in contact with the filling and to cause a little more to be drawn from the shuttle, the filling, consequently, does not tighten enough to raise up the fork. If the shuttle is a little late, the same result will follow, and if the shuttle rebounds a little this will cause the filling to be slack, and the fork cannot be raised up by slack filling and sometimes the filling will drop down below

the fork, owing to either being too slack, or the fork fixed a little too high. Occasionally the filling will loop on the fork, and as the cloth is woven down the fork is caused to swing by the loop of filling, and therefore will often catch on the elbow lever. The looping of the filling on the fork is caused by a rebounding shuttle, too little friction on the filling, one of the prongs of the fork not being level with the rest, or the sliding of the filling down the face of the fork as it is passing through the grate, and also if the fork passes too far through the grate, causing it to be raised too high. so that it rebounds and catches on the filling as the shuttle is passing. It will be noticed by examining this particular point that the filling curls, owing to it being allowed to go slack, and if

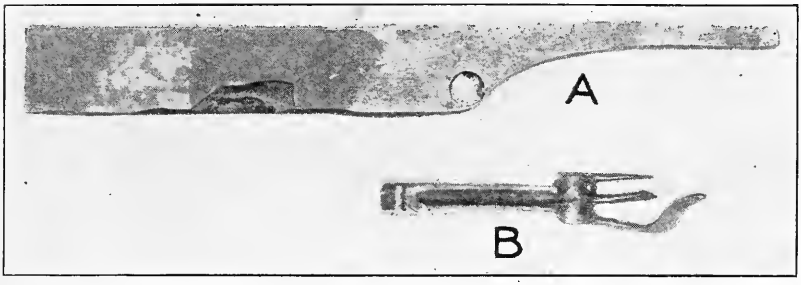


Fig. 137. Worn Parts of Loom Causing Failure to Stop.

the curl happens to drop down toward the sole of the lay, when the fork is fixed as before stated, the defect spoken of will ensue. If the filling is sliding down the fork, it is advisable to dent the prongs a little, but not so that they will cut the filling, just sufficiently to retain the filling. It can also be overcome by having the prongs of the fork straight down from the bend, with a little bend at the extreme end of the fork. One is not always able to fix the fork in this way, owing to the length of the hook in comparison to the way it is fixed to the slide, but so far as this rule can be carried out, it is best, because it not only looks better, but better results follow. When the prongs are pointing out at the bottom it gives the filling a chance to slide up, besides allowing it to pass farther through the grate to raise high enough, and also the point will touch the sole of the lay. If the prongs of the fork are straight down, they pass back a little, whereas the others pass down. An occasional cause for the loom stopping is that the

bearing for the rocker shaft becomes loose; this allows the lay to jump when running, and therefore when the power is off and all seems to be right, it is well to examine these points.

Explanation of Fig. 137.

A. Worn projection receiver.

B. Bent fork.

Wrong Timing of the Stop Motion. It is best to set the cam to move the elbow lever as the crank is passing close to the front center. It is when running two widely different counts of filling that the greatest difficulty is met. For instance, 13's and 90's filling, if you raise the fork the least bit too high with the fine counts you are certain to have trouble with the coarser counts. Have as little friction as possible on the coarser counts, and raise the fork by the finer filling so that it will not quite clear the catch of the lever when the loom is turned over by the hand. In the majority of cases this will give the desired results; if not, then raise the fork a little higher by the fine filling, and add a thin piece of wire to the slide in the form of a bridge, to prevent the rebound of the fork when the coarse filling is being woven, but have the wire loose a little so that as the fork strikes it, the wire will yield a little. Another way would be to scrape the coarse filling shuttle a little so that it will go into the box more easily, but to prevent this from breaking off the filling or spoiling the picker, arrange the check spring to give the resistance required. A source of annoyance, and which is often misleading, is the ticking or occasional rubbing of the dagger against the receiver plate. This gradually pushes off the shipper rod. The main cause for it is that the box is not tight enough, or if it is, the swell is of poor shape.

When using a flat swell that is bolted to the loose portion of the box front, the cause may possibly be that the back end of the swell is bent too far back. Take the shuttle out of the box and notice when the dagger point strikes the receiving plate. It may possibly be striking too high; if it is, this can be altered by the fingers on the dagger rod; loosen them, and have the point of the dagger in the hollow of the receiver; drive on one finger and test it to see if the dagger is right, then drive on the other. When doing this the finger that is set sometimes springs back while

driving the other finger on the rod, and it would be well, therefore, to place a tube or some thin substance between the fixed finger and the swell; then fix the other finger, and it will be found that they are both about equal in the end. The loom will sometimes stop because the stand for the shipper handle, or the shipper handle itself, is worn, and this allows the shipper handle to slide off. It is easily remedied however.

WEAVE ROOM CALCULATIONS.

The calculations in this section will not include those necessary for the construction of cloth; but give all that may be necessary in the routine work of the Overseer, and possibly the Superintendent.

All yarns have a base, foundation and standard number; and this standard must be well known before correct calculations can be made.

The term counts or numbers has the same meaning and determines the number of yards in one pound of the given thread. All yarns with the exception of raw silk are finer of thread as the counts or numbers go higher. There are 7,000 grains in 1 pound avoirdupois: 437.5 grains in 1 ounce.

840 yds. constitute 1 lb. of 1 counts of cotton yarn.
1600 " " " " " 1 run woolen yarn.
300 " " " " " 1 cut woolen yarn.
560 " " " " " 1 counts worsted yarn.
840 " " " " " 1 " spun silk.
300 " " " " " 1 " linen yarn.

Raw silk is generally reckoned by the number of drams that 1,000 yards weigh, using as a base 1,000 yards to one dram of silk, 256,000 yards to 1 pound of 1 dram silk, there being 256 drams in 1 pound. Owing to the difference of opinions among experts as to what constitutes a denier we prefer to calculate by the dram system.

On all yarns except raw silk, to find the number of yards in 1 pound of a given counts of yarn multiply the standard by the given number.

COTTON YARNS.

There are 29,400 yards in 1 pound of 35's cotton $840 \times 35 = 29{,}400$. For greater convenience when dealing with small quantities, one lea or 120 yards is weighed; the 120 is $\frac{1}{7}$ of 840, 1,000 grains or $\frac{1}{7}$ of a pound is also used in the calculations.

If very small quantities are being weighed, a smaller division than $\frac{1}{7}$ can be used, but the standard number of yards (840) and the number of grains in 1 pound (7,000) must be divided by the same number. Rule: divide the standard number of yards, and the number of grains in 1 pound by any number that will give a working basis; then weigh that number of yards and the resultant weight in grains divided by the working basis, will give the counts of yarn in question.

Examples —

120 yds. weigh 20 grs., what is the counts?
1,000 ÷ 20 = 50 counts.

120 yds. weigh 30 grs., what is the counts?
1,000 ÷ 30 = 33⅓ counts.

60 yds. weigh 12½ grs., what is the counts?
500 ÷ 12.5 = 40 counts.

30 yds. weigh 3½ grs., what is the counts?
250 ÷ 3.5 = 71½.

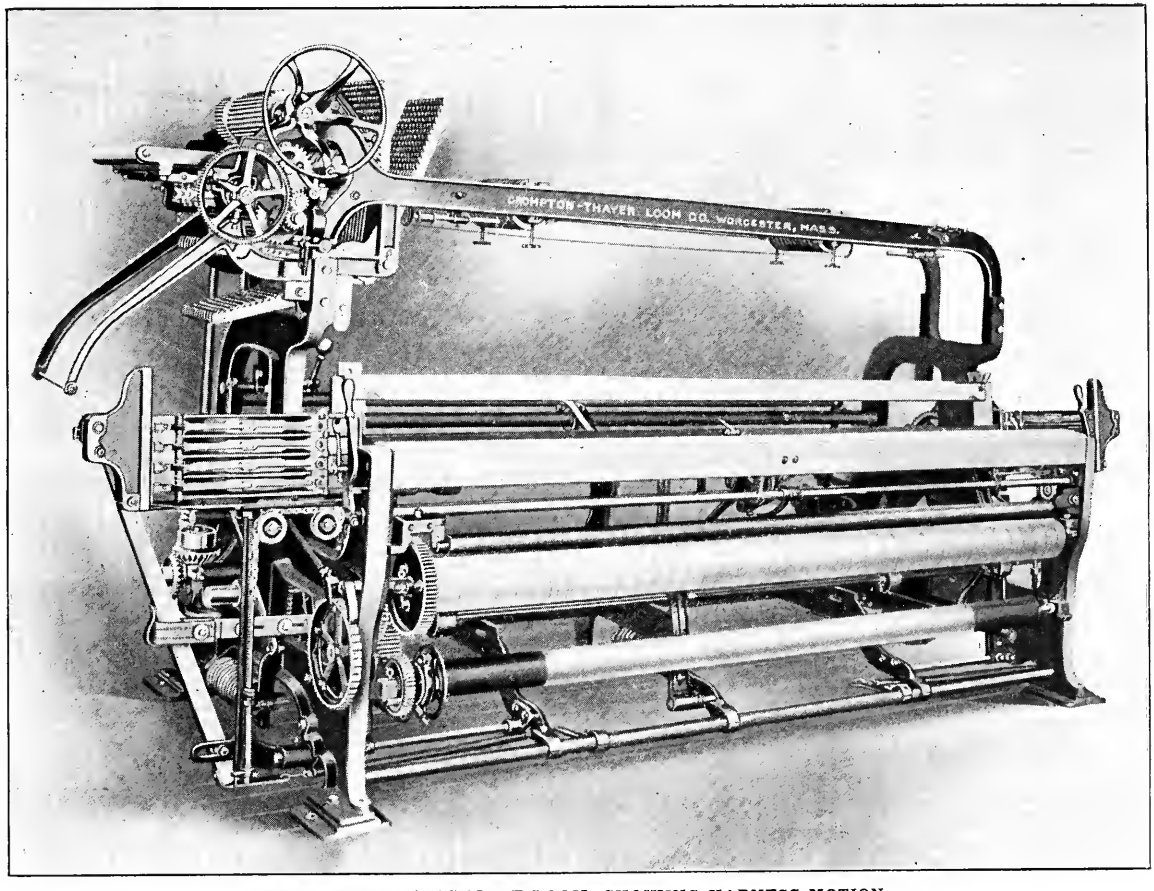
Suppose we have only one-half yard of yarn and we wish to know the counts; following out the previous method of reduction to find a basis, we have the following:

7,000 grs. = 1 lb. 840 yds. are in 1 lb. of 1's counts
or 1,680 half yds. 7,000 ÷ 1,680 = 4.166 grs.

That is one-half yard of 1's counts will weigh 4.166 grains. This is a standard. Weigh half the yard of unknown count and divide the resulting weight by the standard. The quotient will be the counts of yarn.

½ yd. weighs ¼ of a gr. 4.166 ÷ .25 = 16.6 counts.
½ yd. weighs $\frac{1}{10}$ of a gr. 4.166 ÷ .1 = 41.6 counts.

Twisted and ply yarns are denoted as follows: $\frac{2}{10}$'s, $\frac{3}{32}$'s, $\frac{2}{60}$'s, $\frac{6}{30}$'s, and in all yarns with the exception of silk the top figures denote the number of single threads of the given number of counts; the lower figures denote the counts of the single yarn. Cabled



FRONT VIEW OF CASSIMERE LOOM, SHOWING HARNESS MOTION

Crompton-Thayer Loom Co.

yarns are two or more ply yarns twisted together, and are described as $\frac{4}{\frac{2}{60}}$'s, or 8 ends of single 60's.

Although ply threads are slightly heavier than the same number of yards of the single threads before they are twisted (caused by the increased contraction), it is customary when two or more threads of equal counts are twisted, to divide the counts of the single yarn by the number of threads twisted together, and the result is equivalent to a given single yarn: $\frac{2}{\frac{3}{0}} = 30 \div 2 =$ 15's counts. $\frac{3}{75} = 75 \div 3 = 25$'s counts. $4\ \frac{2}{\frac{6}{0}}$'s $= 60 \div (4 \times 2)$ $= 7.5$ counts.

When two or more threads of unequal counts are twisted together, the following is the rule by which to calculate the counts of the combined threads.

RULE. Divide the highest by itself, and by the other counts; add the sum of the quotient of each division and divide the highest counts by the sum, the result is the counts of the combined threads.

What are the counts of the following:

20's and 30's $30 \div 2\frac{1}{2} = 12$ 12's counts.
40's and 35's $40 \div 2.14 = 18.7$ 18.7's counts. Ans.

What are the counts of the combined threads? 30's, 25's and 20's $= 30 \div 3.7 = 8.1$ counts.

WOOLEN YARNS.

The "run" system is the most common method of calculating the counts of woolen yarns. There being 1,600 yards to 1 pound of run yarn, how many yards are there in 1 pound of $4\frac{1}{2}$-run yarn?

$$1{,}600 \times 4.25 = 6{,}800 \text{ yds.}$$

There are 56 pounds of woolen yarn, what is the run and length of the same?

One yard of 1-run woolen weighs 4.375 grains. We weigh 50 yards of this quantity and it weighs $43\frac{3}{4}$ grains.

$218.75 \div 43.75 = 5$ run yarn.
$1{,}600 \times 5 \times 56 = 448{,}000$ yds. of yarn.

When calculating for the cut system proceed in the same manner, but substitute for the cut standard 300 yards.

WORSTED YARNS.

How many yards are there in 1 pound of 30's worsted?

$$560 \times 30 = 16{,}800 \text{ yds.}$$

We have 16,800 yards of 40's worsted, what is the weight?

First find the number of yards in 1 pound of 40's, then proceed.

$$560 \times 40 = 22{,}400.$$
$$16{,}800 \times 16 = 268{,}800. \quad 268{,}800 \div 22{,}400 = 12 \text{ oz. of yarn.}$$

We know that one yard of 1's counts of worsted weighs 12.5 grains; if 3 yards weigh $1\frac{1}{4}$ grains what is the counts? Divide the base for worsted by the yards weighed to get the working number of grains and yards.

$$560 \div 3 = 186.7. \quad 7{,}000 \div 186.7 = 37.5 \text{ grs.}$$
$$37.5 \div 1.25 = 30 \text{ counts of yarn.}$$

Three yards is $\frac{1}{186.7}$ of 560 yards. 37.5 grains is $\frac{1}{186.7}$ of 7,000 grains.

SILK—RAW.

There is a distinctive difference between spun and raw or reeled silk.

Spun silk is made from waste silk and the poorer qualities of cocoons, and the fibre passes through similar processes to cotton before it is made into yarn. Raw silk means silk that is reeled from the cocoon, the strands of silk are then doubled and twisted to make tram or organzine, the former for filling, the latter for warp.

Tusser or Tusseh silk, is a raw silk from the wild silk worm of India.

There are two distinct standards for determining the counts or sizes of raw silk yarns: Denier and Dram. A hank of 520 yards is used as a base, and the number of deniers such a hank weighs, denotes the counts or size of the yarn. $533\frac{1}{3}$ deniers equals 1 ounce avoirdupois.

When using the dram as the standard of calculation, the counts required of the silk reeled is the number of drams 1,000 yards weighs.

If 1,000 yards weigh $6\frac{1}{4}$ it will be $6\frac{1}{4}$ dram silk. The number of yards in 1 pound of $6\frac{1}{4}$ dram silk is found as follows:

$1{,}000 \times 16 \times 16 = 256{,}000$ yards in 1 pound of dram silk. As stated the higher the numbers the less number of yards in 1 pound of run silk; so that dividing the base by the weight of 1,000 yards in drams will give the number of yards in 1 pound of the yarn.

$256{,}000 \div 6\frac{1}{4} = 40{,}960$ yds. in $6\frac{1}{4}$ dram silk.

A less number of yards can be weighed, and the result multiplied by the divisor of the standard. For example:

500 yards is one-half of the standard and weighs $2\frac{1}{2}$ drams. $2\frac{1}{2} \times 2 = 5$ drams silk.

$256{,}000 \div 5 = 51{,}200$ yds. 1 lb.

100 yds. weigh .75 drams. $.75 \times 10 = 7.50$ or $7\frac{1}{2}$ drams.

$256{,}000 \div 7\frac{1}{2} = 34{,}133.3$ yds. 1 lb.

Spun silks are calculated by the same standard as cotton. 840 yards = 1 pound of 1's counts.

The higher the numbers the greater number of yards to a pound.

Single 40's and two-fold 40's require the same number of hanks to the pound, and the two-fold is indicated in the opposite manner to other yarns. $\frac{40}{2}$ = 40's.

Calculating for spun silks, the indicated counts would be considered; not the ply.

LINEN. COMBINED YARNS.

Linen yarns are reckoned the same as the cut system, woolen yarns. In fancy mills it is common to have several kinds of yarn woven in the same cloth, viz.: Cotton and Wool, Worsted and Wool, Worsted and Cotton, Cotton and Silk, Worsted and Silk. To find the equivalent counts, multiply the standard of the given thread by the counts, and divide by the standard of the required thread. What counts of woolen yarn, run system, equals a 30's cotton thread?

$840 \times 30 = 25{,}200.$

$25{,}200 \div 1{,}600 = 15\frac{3}{4}$ run woolen yarn.

What counts of woolen yarn, cut system, is equivalent to a $\frac{1}{20}$'s worsted yarn?

$$20 \times 560 = 11{,}200.$$
$$11{,}200 \div 300 = 37\tfrac{1}{3} \text{ cut woolen yarn.}$$

Any other combination of yarns can be found in the same manner as the above.

To find the counts of yarn that is on a beam, the weight and length being known.

Multiply the number of ends in the warp by the length, to get the total number of yards of yarn; divide by the weight multiplied by the standard of the yarn.

If 4,095,000 yards weigh 65 pounds, what is the counts?

$$\frac{4{,}095{,}000}{65 \times 840} = 75 \text{ counts.}$$

A stock warp is found, and the comparative weight of the beam is known, also the counts, what is the length of warp?

The beam and warp weigh 200 pounds., beam about 95 pounds and there are 2,780 ends on the warp, the counts is $\frac{2}{40}$'s worsted.

Multiply the yards in 1 pound of the given counts by the number of pounds of warp; and divide by the ends in the warp. The result will be the number of yards length of warp.

$$200 - 95 = 105 \text{ lbs. of yarn.}$$
$$\frac{11{,}200 \times 105}{2{,}780} = 423 \text{ yds. of warp.}$$

Suppose the number of ends in a warp is not known, but other data is known; to save the time of counting the threads the following rule can be applied.

Multiply the counts by the standard and the weight; then divide by the length.

A warp of 45 counts, 60 pounds in weight, 1,350 yards in length, what is the number of ends in the warp?

$$\frac{45 \times 840 \times 60}{1{,}350} = 1{,}680 \text{ ends.}$$

STOCK TAKING.

When taking stock it is the common practice to guess at the length of yarn there is on the beams, but to be more definite the

following rule can be followed. Subtract the number of pieces woven from the original number, multiply by the length, allowing for the approximate length of cloth on the roll, and the result will be the length of warp on the beams.

A warp originally had on it 60 pieces, 5 yards in length; 7 pieces have been woven, what is the length of the warp on the beams?

$$60 - 7 = 53. \quad 53 \times 54 = 2{,}862.$$

About 10 yards of cloth on the roll. $2{,}862 - 10 = 2{,}852$ yards.

The above is only the approximate length, but it is nearer than a guess, and a guess is likely to be a good many yards out.

What weight of warp would be required to make a warp of 90 pieces, 55 yards in a piece 2,440 ends in width, 40 cotton?

Multiply the pieces by the length of each piece and by the number of ends, divide by the number of yards in 1 pound of the given counts.

$$\frac{55 \times 90 \times 2.440}{40 \times 840} = 359.762 \text{ lbs. of yarn.}$$

Allowing 3 per cent waste in transferring the yarn,

$$359.762 \times 1.03 = 370.55 \text{ lbs. required.}$$

Whatever kind of yarn is being used, or the quantity required, the foregoing rule can be applied, using the approximate per cent of loss in transferring the yarn.

The sley means, the number of ends per inch in the reed, but often cloths are made with stripes in them that have more ends in some dents than in other portions of the cloth, and when calculating for the number of ends in the full width the average only is taken.

What are the number of ends and weights of yarn required in a warp as follows: $\frac{1}{4}\frac{2}{}$ that is 12 reed 4 in 1 dent 72″ in width, 424 yards in length, $3\frac{3}{4}$ woolen yarn?

Multiply the number of ends per inch by the number of inches in width, also by the number of yards there are in the length, to get the total number of yards of yarn there are in the warp. Divide the total number of yards of yarn by the number

of yards in 1 pound of the given counts of yarn. The result will be the weight of warp.

$$48 \times 72 = 3{,}456 \text{ ends in warp.}$$
$$3{,}456 \times 424 = 1{,}465{,}344 \text{ yds. in warp.}$$
$$1{,}465{,}344 \div 6{,}000 = 244.224 \text{ lbs. of yarn in the warp.}$$

A piece of cloth is required to be made as follows: A plain and satin striped cloth, 32″ in width aside from selvedges; plain stripe to be made $\frac{3}{4}$″ in width, 2 ends in 1 dent; satin stripe to be $\frac{1}{4}$″ in width, 4 ends in 1 dent, 40 reed. Selvedge to have 10 double ends in each side, and both edges of the cloth to be the same.

We have 125 pounds of 65's cotton yarn. What length of warp can be made from above particulars? Also give particulars for drawing the warp in the harness.

$$840 \times 65 = 54{,}600 \text{ yds. in 1 lb.}$$
$$54{,}600 \times 125 = 6{,}825{,}000 \text{ yds. total.}$$

$\frac{3}{4}$″ of a 40 reed would be 30 dents $30 \times 2 = 60$ ends of plain per inch.
$\frac{1}{4}$″ of a 40 reed would be 10 dents $10 \times 4 = 40$ ends of satin.
$100 \times 32 = 3200$. $3200 + 40 = 3240$ ends in the width.

$$6{,}825{,}000 \div 3{,}240 = 2{,}106.48 \text{ yds. of warp.}$$

Draw the plain stripe on the 4 harness and the satin stripe on the 6 harness.

Draw the selvedge, then commence the $\frac{3}{8}$″ of plain. Afterwards start with the full pattern $\frac{1}{4}$″ satin, $\frac{3}{4}$″ plain, and the finish will be the same as the commencement.

$60 \times 32 = 1{,}920$, $1{,}920 + 10 = 1{,}930$. $1{,}930 \div 4 = 482.5$ heddles.
$40 \times 32 = 1{,}280$, $1{,}280 \div 6 = 213.3$ heddles.

Place 483 heddles on each shaft for the plain and the 214 on each shaft for the satin.

TO FIND THE PRODUCTION OF A LOOM.

Multiply picks per minute by minutes in 1 hour, and by hours per day or week. Divide by picks per inch, then by inches per cut; the result will be the mathematical production; but the loom stops for change of filling, etc., so that the actual production will be less than the above; the loss can only be surmised until a test has been made, but let your aim be to get the highest production possible consistent with quality.

Speed for loom 168 picks per min.
60 min. per hr.
10,080
58 hr. per week.
Picks per in. 64)584,640
In. in 45 yds. 1,620) 9,135
5.638 cuts of 45 yds. in 58 hrs.
.850% of production, or allowing 15% for stoppage.
4.788 = Actual production per week.

TO FIND THE PER CENT OF PRODUCTION.

First find the mathematical production, then divide the actual production of the machine by the mathematical, and the answer will be the per cent of production.

Mathematical 5.5)4.35 actual production.
.79 = 79%.

To find the percentage of production when yards are considered; substitute yards for cuts and proceed as above.

EXAMPLES.

If 6 looms produce 3,624 yards in 12 days, how many will 40 looms produce in 6 days?

There are two ways of obtaining the result required:

First: Find the average yards that one loom produces in the first case, then multiply the average by the second case.

Yds. Days. Looms.
Example: 3,624 divided by 12 divided by 6 = 50.33 yds. in 1 day.

Yds. Days. Looms.
50.33 × 6 × 40 = 12079.20 yds.

Second Method: Proportion. Proportion is an equality of ratios. Ratios is the relation of one quantity to another of the same kind.

Place the number that is the same as the required answer in the third term, and if the question indicates that the answer ought to be larger than the third term, place the remaining terms with the larger one in the second place; then divide the product of the second and third terms by the first to obtain the fourth or answer.

Cancellation assists in the shortening of the sum.

In the example we require yards, and a greater number than

the third term, and as we have five sets of figures, to find the relation of one to the other, place them in this order.

Looms	to	Looms
6	:	40
Days	to	Days
12	:	6
Yds.	to	Yds.
3,624	:	x

$$\frac{40 \times 6 \times 3{,}624}{12 \times 6} = 12{,}080 \text{ yds.}$$

If 28 looms produce 1;400 yards of fancy cloth in 6 days of $10\frac{1}{4}$ hours per day, how many yards will 36 looms produce in 3 weeks, 58 hours per week?

First, reduce the days or weeks to hours.

$10\frac{1}{4} \times 6 = 61\frac{1}{2}$ hours. $58 \times 3 = 174$ hours.

Looms	to	Looms
28	:	36
Hours	to	Hours
$61\frac{1}{2}$	:	174
Yds.	to	Yds.
1,400	:	x

$$\frac{\cancel{36} \times 174 \times \cancel{1{,}400}}{61\frac{1}{2} \times \cancel{28}} = \frac{9 \times 174 \times 200}{61.5} = 5092.68 \text{ yds.}$$

$\cancel{36}$ → 9; $\cancel{1{,}400}$ → 200; $\cancel{28}$ → 7

It is often necessary to produce a larger number of yards of cloth in a given time, so that small warps have to be placed in several looms to comply with the order.

Example:

Thirty pieces of worsted cloth, 60 yards in a piece, must be woven in 15 days. How many looms, and number of pieces to a loom, are required to weave the cloth in the given time?

One loom weaves 116 yards per week of 58 hours.

First find the number of yards per hour, then the length of time it takes one loom to weave one piece; divide the result into the time allowed, and the answer will be the number of pieces one loom can weave in the given time. Divide the total number of pieces by the production of one, and the result will be the number of looms required.

116 ÷ 58 = 2 yds. 60 ÷ 2 = 30 hours to weave 1 piece.
58 ÷ 6 = 9.7 average hours per day.
15 × 9.7 = 145.5 total hours.
145 ÷ 30 = 4 85 pieces produced by each loom in the given time.

It would be better under the circumstances to use 8 looms, placing 4 pieces in 7 looms and 2 pieces in one loom. This will allow time for accidents.

When a break-down occurs, note is taken of the length of time the loom or portion of it is stopped, and instead of sending in a report, that so many looms were stopped for so many hours, it is customary to divide the total number of looms in the room by the fraction of time that the looms were stopped, and the result will represent that so many looms ran the full time.

Example:

There are 580 looms in a room, and through a break-down the looms are stopped 4 hours, how many ran full time?

The working hours are 58 per week.

$$4)58 \qquad 14.5)580$$
$$14.5 \qquad 40 \text{ looms stopped.}$$

$$580$$
$$40$$
$$540 \text{ looms run full time.}$$

When looms are stopped for lack of weavers, the above rule can be applied, but a record ought to be kept of the reason why they are stopped.

To figure the pay per hour for odd help, whatever work they are performing: Divide the amount per week by hours of work: for several hours: multiply the rate per hour by the number of hours of labor.

A spare hand weaver is paid at the rate of $8.00 per week, and works $10\frac{1}{2}$ hours, what will be the price paid? Fifty-eight hours constitutes a week's labor.

$$58)\$8.00$$
$$13.79 \text{ cents per hour.}$$
$$10.5 \text{ hours of labor.}$$
$$144.795 = \$1.44 \text{ per day.}$$

Two days would be $2.89, three days $4.34, and so on; multiply the fraction of a cent each time.

Example:

An operative is paid $1.75 per day, and receives an increase of 5 per cent, what will be the wages paid?

There are two methods by which the amount can be computed. First, by finding what is 5 per cent of the wages already paid, and adding that amount; the sum will be the wages that has to be paid.

Second: Multiplying the amount paid by one plus the per cent.

175	1.75	
.05	8	
8.75	1.83	$1.83 per day.
175		
1.05		
875		
175		
183.75	$1.83 per day.	

Suppose after a few months the same operative was reduced 5 per cent, will the former wages be paid? No.

1.83	1.83	
.05	9	
9.15	1.74	$1.74 per day.

Or

```
1.05)1.83(1.74
     105
     780
     735
     450
     420
      30
```

$1.74 per day.

To find the per cent of reduction and increase, subtract the difference, divide this by the first value, and the result will be the per cent of reduction.

Example:

Ninety-five cents is paid for weaving a piece of cloth, the price is then reduced to 85 cents, what is the per cent of reduction?

```
 95
 85
95)10.0(.105
  95
  500
  475
   25
```

$10\frac{1}{2}\%$ reduction.

Reduced from 25 cents to 23 cents.

```
25
23
25) 2.00(.08
   200
```

8% reduction.

Increased from $1.56 to $1.62.

$$
\begin{array}{r}
1.62 \\
1.56 \\
\hline
1.62)\ .0600(.037 \qquad \text{About } 3\tfrac{7}{9}\% . \\
\underline{\ 486} \\
1140 \\
\underline{1134} \\
6
\end{array}
$$

TO FIND THE COST OF PRODUCTION.

1. A spare hand weaver receives $8.50 per week, and produces 825 yards from 5 looms, what is the cost per yard?

$$\$8.50 \div 825 = 1.03 \text{ cts. per yd.}$$

2. A weaver is paid $8.50 for producing 15 pieces of cloth each 55 yards in length, what is the cost per cut?

$$\$8.50 \div 15 = 56\tfrac{2}{3} \text{ cts. per cut.}$$

3. A weaver produces 240 yards of cloth and has to receive $5\frac{1}{2}$ cents per yard, what is the amount paid?

$$240 \times .055 = \$13.20.$$

Or for each piece of 40 yards, $2.20. $40 \times .055 = \$2.20$.

4. A loom produces in one week, three pieces of 45 yards in each piece, total 155 yards. 85 cents is paid for each piece, total cost $2.55, what is the cost per yard?

$$255 \div 155 = 1.65 \text{ cts. per yd.}$$

Cost Per Pound.

A weaver has four looms, each loom has a different pattern in it, with prices paid in proportion, as follows:

1. Leno striped cloth, 50 yards in length of cut, 73 cents per cut; weight, 5.09 yards per pound; average 4 cents per week.

2. Bedford Cord. 50 yards in length of cut, 70 cents per cut; weight, 3.19 yards to the pound; average 3.5 pieces per week.

3. B. C. Leno. Length of cut 70 yards, $1.38 per cut; weight, 4.20 yards per pound; average 3 pieces per week.

4. Fancy Mercerized Stripe. Length of cut 70 yards, $1.30 per cut: weight, 4.07 yards to the pound; average 3 pieces per week.

What is the cost per pound in each case?

	Yds. in Cut		Yds. in 1 Lb.	
1.	50	÷	5.09	= 9.82 lbs. in 1 cut of 50 yds.
	Cents			
	73	÷	9.82	= 7.44

or expressed in cost of cts. per lb. the answer would be $.0744 per lb.

	Yds. in 1 Cut		Yds. in 1 Lb.	
2.	50	÷	3.19	= 15.67 lbs. in 1 cut of 50 yds.
	Cents			
	70	÷	15.67	= 4.46 or $.0446 per lb.
	Yds. in 1 Cut		Yds. in 1 Lb.	
3.	70	÷	4.20	= 16.67 lbs. in 1 cut of 70 yds.
	Cents			
	138	÷	16.67	= 8.27 or $.0827 per lb.
	Yds. in 1 Cut		Yds. in 1 Lb.	
4.	70	÷	4.07	= 17.19 lbs. in 1 cut of 70 yds.
	Cents			
	130	÷	17.19	= 7.56 or $.0756 per lb.

To find the percentage of warp and filling in a piece of cloth. proceed as follows, using cloth No. 1 as an example: 102 threads per inch; 64 picks per inch; 27 inches in width. 30's warp; 40's filling; 50 yards in length.

To find the amount of warp yarn.

Threads per In.		In. Wide		Length in Yds.	
102	×	27	×	50	= 137,700 yds. of warp.

To find the amount of filling.

Picks per In.		In. Wide		Length in Yds.	
64	×	27	×	50	= 86,400 yds. of filling.

Or $64 \times 27 \times (36 \div 36) \times 50 = 86{,}400$ yds. of filling.

Add together the total weights of warp and filling, and divide the separate amounts by the sum of the addition; the result will be the percentage of each.

137,700
86,400
224,100 lbs. of yarn.

$137{,}700 \div 224{,}100 = .6144 = 61.44\%$ of warp.

$86{,}400 \div 224{,}100 = .3855 = 38.55\%$ of filling.

To find the weight of warp and weight of filling in cloth No. 1.

Multiply the weight of a cut of cloth by per cent of warp to find the weight of warp; then subtract the weight of warp from the weight of the cut, and the result will be the weight of the filling.

$9.82 \times .6144 = 6.033408$ lbs. of warp or $6\frac{3}{100}$ lbs. of warp.

$9.822 - 6.033408 = 3.788592$ lbs. of filling or $3\frac{3}{4}$ lbs. of filling.

The amount of filling required per day is in proportion to the number of yards woven in one day, and can readily be estimated.

If a third of a cut is woven in one day,

$$3\tfrac{3}{4} \div 3 = 1.25 \text{ lbs. of filling.}$$

To find the cost of yarn, both warp and filling, in cloth No. 1. 30's warp cost 21 cents per pound. 40's filling cost 23 cents per pound.

Weight of warp yarn,

$$6.033 \times 21 \text{ cts.} = 126.693 \text{ or } \$1.26\tfrac{2}{3}.$$

$$3.786 \times 23 \text{ cts.} = \frac{87.078}{213.771} \text{ or } \frac{\$ \ .87}{\$2.13\tfrac{3}{8}} \text{ total cost.}$$

To find the amount of cloth a given quantity of filling will make, other data known.

Cloth No. 1. If $3\frac{3}{4}$ lbs. of filling will make 50 yards of cloth, how many yards will 20 pounds make?

Lbs. Lbs. Yds. Yds. Required

$$3.75 : 20 :: 50 : x$$

$$\frac{20 \times 50}{3.75} = 266.6 \text{ yds. of cloth.}$$

It is a well-known fact that 70 yards of warp yarn will not make 70 yards of cloth, owing to the interlacing of the warp yarn with the filling; so that when figuring out the length of cloth required, the shrinkage of the warp must be taken into consideration. The amount of shrinkage or take-up can only be determined by actual practice, but approximate shrinkage can be determined by measuring a length of woven yarn.

Example: Cloth No. 1 on which two warps were used.

Warp No. 1. 2,456 ends $\frac{1}{30}$'s 6% shrinkage.
Warp No. 1. 156 ends $\frac{2}{20}$ 15% shrinkage.

Twenty pieces of 70 yards each were woven, what was the actual length of both warps?

Yds.

$$70 \times 1.06 = 74.20 \text{ yds. in each cut.}$$

$$74 \times 20 = 1{,}480 \text{ yds. on the warp.}$$

$$70 \times 1.15 = 80.50 \text{ yds. in each cut.}$$

$$80.50 \times 20 = 1{,}610 \text{ yds. on the warp.}$$

To find percentage of size added to the warp yarn.

The weight of the yarn before it is sized can be ascertained by the usual method: Multiply the number of ends by the length,

and divide by the number of yards in 1 pound of the given counts; add to the answer the weight of the beam. Subtract the final result from the weight of a warp doffed from the slasher; the difference will be the amount of size that has been added. To find the per cent proceed as follows:

A warp is made of 3,500 ends, 1,200 yards 60's cotton.

The warp weighs 135 pounds after it has been sized, the empty beam weighing 48 pounds. What percentage of size has been added to the yarn?

Ends in Warp		Yds.	
3,500	×	1,200	= 4,200,000 yds. total.
Yds.		Counts	
840	×	60	= 50,400 yds. in 1 lb.
4,200,000	÷	50,400	= 83.33 lbs. of unsized yarn.
Lbs.		Lbs.	
135	—	48	= 87 lbs. of sized warp yarn.
87.00			
83.33			
3.67	difference		3.67 ÷ 83.33 = .044 or $4\frac{4}{10}$%.

Or

87.00	
83.33	
3.67	
100	
83.33)367.00	
4.4	$4\frac{4}{10}$% size added to the warp.

Speed and gear calculations are found in another section.

There are several reports and order sheets in connection with the weave room; The first one is an order sheet as follows: and is passed to the Overseer from the Superintendent.

THE ISA MANUFACTURING CO.

No. 1.

Ordered 5 *Mo.* 10, *1902*

Mr. Smith *Overseer* Weave *Room*

Style No. 1,892 *Sample No.* 1,910

Total pieces 2,000 *Weekly delivery* 150 *Delivery begins* June 4

Reed 24 *Pick* 80 *Aver Sley* 96 *Aver Pick* 80

Width in Reed 30 *Width of Cloth* 28

No. Ends 1,773 *Counts Warp* 36 *Yds. in Cut* 70

" 342 " " 2-40

" 114 " " 2-20

" " "

Counts Filling 20 *Aver No.* 21

Yds. per lb. 4.07 *Speed* 175

Prod. per day in yards 25 *Lbs.* 6.14 *Per cent* 75

Weave Mer Stripe

Price per cut $1.30

Remarks

If necessary change 2,630 to get this out on time.

J. HARRIS, Supt.

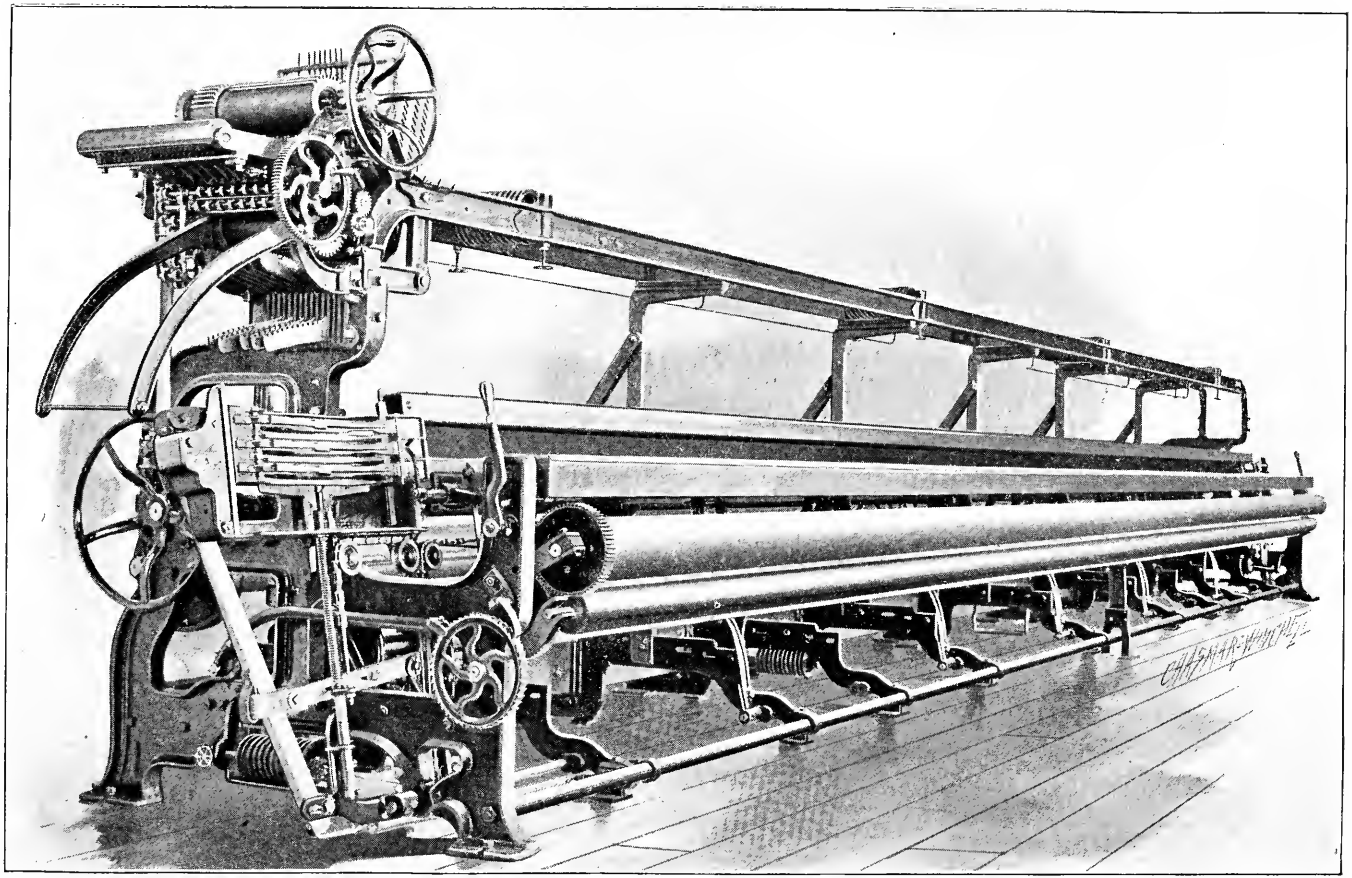
THE ISA MANUFACTURING CO.

No. 2.

Ordered 5-10-1902

Style	1892	
Slasher No.	2	
No. Yarn	36	
Section Beams	4	443
		443
		443
		444
Spools		
Total Ends		1773
Length of cut	70	
Gear	26	
Color of Mark	Red	
No. of Filling	20	
Price Drawing	$1.15	
No. of Cuts	2,000	
No. of Warps	80	

Finished June 26, 1902.



KNOWLES HEAVY FELT LOOM WITH 382-INCH REED SPACE

Crompton & Knowles Loom Works

WEAVE ROOM REPORT.

Week ending.....

No. 3.

No. of Looms.	Weaver's Name.	Style.	No. of Cuts. Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Total.	Price Per Cut.	Total.	Charges Seconds.	Spare Hand.
1.		2,630		1-1 / 1-19			1-1 / 2021		4	.73	$2.92		
2.	Mary Todd	2,160	1-1 / 11.12			1-1 / 13.14			4	.70	2.80		
3.		1,960	1/9		1/10			1/11	3	1.38	4.14		
4.		1,892		1/4		1/5		1/6	3	1.30	3.90		
5.													
6.													

WEAVE ROOM.

SEPT. 22, 1902.

No. 4.

Section No. 1.

Take off looms on style 2,630.
Put on 6 looms on style 1,960.
Weave; mercerized stripe.

Width in reed	30½″
Width in cloth	28
Picks	81
Gear	40
Filling	40
No. harness	16
No. beams	3
Size of pulley	14½″

Remarks:

Bring a sample yard and a small piece into the office.

J. SMITH, *Overseer.*

THE ISA MANUFACTURING CO.

REPORT OF

WEAVING DEPARTMENT.

No. 5. For the week ending June 4, 1902.

				Time	Production	Price	Amount	
1.	Overseer	1	day	6	$4.00	$24.00	$24.00
2.	Second Hands	2	hour	58	27.68	16.00	32.00
3.	Fancy Fixers	18	hour	58	.25	14.50	116.00
4.	Plain Fixers	4	hour	58	23.45	13.60	54.40
5.	Change Fixers	2	hour	58	18.96	11.00	22.00
6.	Smash Piecers	2	hour	58	17.67	10.25	20.50
7.	Filling Tenders	2	day	6	1.25	7.25	14.50
8.	Filling Tender	1	hour	58	11.379	6.60	6.60
9.	Laborer	1	day	6	1.25	7.25	7.25
10.	Scrubber	2	hour	58	10.34	6.00	12.00
11.	Oiler	1	hour	58	12.93	7.50	7.50
12.	Cloth Booker	1	hour	58	14.65	8.50	8.50
13.	Weavers' Spare Hands	6	hour	58	17.068	9.90	59.40
14.	Total						$384.65
15.	Weavers' Allowance		hour	29	17.068	4.95	4.95
16.	Pounds Woven			64,141		Cost	2,372.30
17.	Total Cost						$2,761.80
18.	Cost per lb.					.0430	
19.	Cost of Weaving per lb.					.0369	

Pounds Soft Waste	63
Pounds Hard Waste	
Pounds Sweepings	80

No. 2 is given to the overseer of the dressing room, which states the particulars necessary for him, namely: Number of warps; cuts on each warp; slasher length of each cut, or gear, owing to the length of yarn being larger than the cloth length.

No. 3 shows the form of a weave room report, which is exposed in some convenient place, generally near the cloth board.

The small figures represent small paper checks that the weavers are supplied with to sew on the cloth, and which indicate one or more pieces; the checks are numbered, the number acting somewhat as a remedy against mistakes.

Charges mean money deducted for second quality cloth, and loss through non-attendance at work.

A red mark is generally placed alongside the particular piece of cloth that is considered as seconds. Also the weavers who are not up to the average in production have a mark attached to their names.

No. 4 shows an order that is handed to the second hand by the overseer and explains itself.

No. 5 summarizes the cost of odd help, and under the head of miscellaneous cost is balanced with the cost per pound for weaving.

Item 14 on this sheet gives the total cost of miscellaneous help.

Item 15 is the sum allowed to a weaver who had a poor weaving warp in the loom, or it is sometimes charged as pattern weaving.

Item 16, pounds of cloth woven and the cost.

Item 17, the total cost of producing the cloth in the weave room.

Item 18, the cost per pound, obtained by dividing item 17 by pounds woven.

Item 19 is obtained by dividing cost of weaving by pounds woven; both items under item 16.

TO FIND THE COST OF PRODUCTION IN THE WEAVE ROOM.

Competition is so keen that it is necessary to know the cost of production of each yard of cloth, and the only way to find that

cost is to summarize the production and the cost, then balance one against the other.

No. 6.

SUMMARIZED LIST.

1.	Number of looms running		371
2.	Number of pieces woven		2,218
3.	Number of yds. woven		114,396
4.	Number of lbs. woven		15,094
5.	Number of yds. per loom		308
6.	Number of lbs. per loom		40½
7.	Average number of weavers on each style		46.38
8.	Average number of lbs. to a weaver		326
9.	Cost of weaving	$439.16	
10.	Miscellaneous cost	57.97	
11.	Cost of weaving per lb.		.0291
12.	Miscellaneous cost per lb.		.0038
13.	Total cost of production		.0329
14.	Total cost of production	$497.13	

Items 1, 2, 3, 4, 8 and 9 explain themselves, and are necessary to find the answer to the remaining items. To find the yards per loom, divide the yards woven by number of looms running; to find the number of pounds per loom, divide item 4 by item 1; to find the cost of weaving per pound, divide the cost of weaving by the number of pounds; to find the miscellaneous cost per pound, divide the miscellaneous cost by number of pounds; to find total cost add items 9 and 10. The miscellaneous item means the cost of all odd help, such as fixers, filling carriers, scrubbers, oiler, cloth booker, laborer.

To find the average number of weavers on each style, divide the number of looms running on that style, by the number of looms to a weaver.

To find the number of pounds to a weaver, divide the number of pounds of that style by average weaver.

No. 6 is computed from Nos. 3 and 5, but the items from No. 3 are first classified in a book kept for the purpose, which will show so many looms weaving style 2,630. There is also a separate account kept of persons employed and wages paid.

Mills have different systems, but the foregoing show one method of keeping the weave room accounts.

Instruction sheet No. 7 and report sheets Nos. 8 and 9, are generally used in a woolen and worsted mill with slight changes in methods.

Report sheet No. 8 is the one used in the weave room, and indicates to the weaver how much cloth has been used.

In worsted mills and generally in woolen mills, the piece is marked down instead of the number of yards per half day as shown on this sheet. These sheets are generally made to cover one month's work.

No. 9 is the report of one week's production in the weave room.

BANHUC MANUFACTURING CO.

INSTRUCTIONS FOR MANUFACTURING STYLE. 27″ TRICOT PATTERN, 1,673.

No. 7.

Threads in warp	2,430	Length from loom per piece	40
Ends per in. finished	30	Finished length of piece	39-38
Size of warp	5⅜	Finished width of piece	27″
Reed	2/13 2	Finished weight per yd.	2.7
Inches wide in reed	30		
Picks of filling	26		
Size of filling	4⅞		
Weight from loom per yd.	8.5		

Remarks:

$1.85 for 80 yds. 14 pieces per week.

BANHUC MANUFACTURING CO.

WEAVING.

No. 8.

Pay No.	Date	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Amount
58	Time	10½	10½	10½	10½	10½	5½	
	Style 27/300							
Loom No. 1-2								
	Yds.	38	40	40	39	38		
		39	38	40	38	38	39	
1	Price	1.85	1.85	1.85	1.70	1.70	.85	$9.80

BANHUC MANUFACTURING CO.

WEAVING.

No. 9.

Hours worked, 58.

Waste lbs.
Per cent waste.

Width	Style	Looms	Cuts	Pieces	Pounds	Yards	Aver. Oz.
35	2,402	7	19	38	771¼	2,130 2	5.8
27	300	44	206	618	5,101	24,699 3	3.3
32	184	2	4	8	84	315 2	4.3
27	550	47	222	666	5,518¼	26,559 2	3.3
36	179	1	5	10	161	361 2	7.0
		101	456	1,340	11,635½	54,066¾	

HUMIDITY IN THE WEAVE ROOM.

Humidifying the atmosphere is of two-fold value; each value will be taken separately. First, it is a well-known fact that filling requires to be conditioned, that is, passed through a moistening process before it will weave acceptably; as this is true of filling more particularly is it true of warp yarn after it has been sized.

While the sizing compound is expected to lay the fibres to a greater or less extent, the necessity of drying the yarn before it passes on to the beam, takes out the natural moisture from the fibre, causing the yarn to be more or less brittle, destroying somewhat the elasticity of the yarn. The retention or loss of elasticity means, the retention or loss of brightness or lustre to the yarn; consequently the product will not have the bright appearance and finish that is absolutely necessary in a good piece of cloth, if the elasticity is taken out. To condition and bring the warp yarn as near as possible to natural conditions, so that the production may be of the best both as to quality and quantity, what has to be done? The room must be kept in such a condition, especially on dry days, so that there is sufficient moisture in the air to somewhat penetrate the size on the yarn, and in this way condition the fibres, actually strengthening them for the work they have to do.

The extent to which the air in a room is moistened is termed relative humidity, which means the amount of moisture in the air as compared with the amount the air would contain if it was thoroughly saturated; and when the temperature of the room is lowered with the same amount of moisture in it, the moisture in the air would be condensed and settle on the machines. Heating the room with the same amount of moisture in the air would have the opposite effect, making what is termed a dry atmosphere.

It is to overcome this dry atmosphere and regulate the humidity of the room, that the "Air Moistening System" has been brought to such a state of perfection, and by the use of such a system as shown in Fig. 138, the relative humidity can be so arranged and controlled, that the best results can be obtained.

Second, from the standpoint of a room that is dry and charged with electricity. It is a well-known fact to mill men in general, that the humidity of a weave room materially affects the production of the loom; the friction from the belts generates electricity

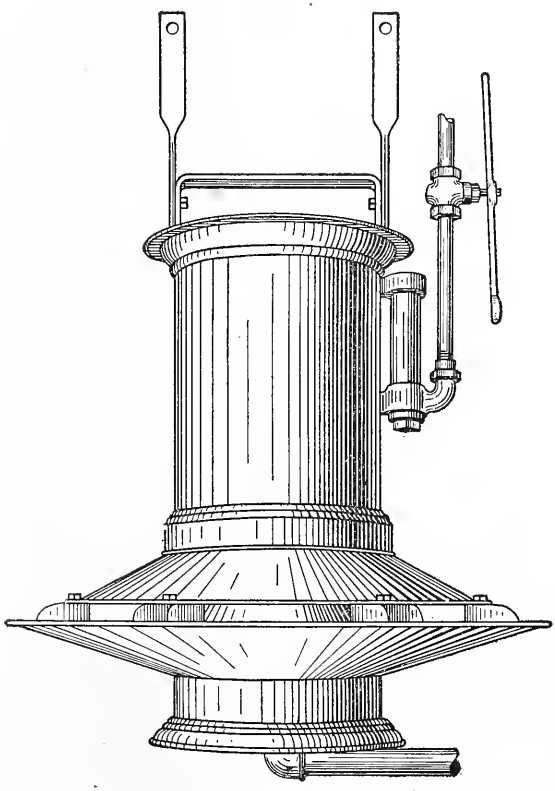


Fig. 138. Humidifier of the American Moistening Co.

to such an extent that the atmosphere becomes dry, and this dryness acts in such a manner on the yarn that the fibres open out and the yarn becomes beardy or hairy; the yarn loses in strength and in addition will not weave as well as it should; the threads not only cling together in the shed, preventing a clear open space for the shuttle to pass through, but as they pass between the leese rods the loose fibres work out from the yarn and form in bunches on the yarn; often two or more threads will be fixed together by these bunches and when they weave up to the harness one or more of them will break out. In addition, if the bunch happens to work through the heddle to the reed, the oscillations of the reed cause more loose fibres to gather with the already large bunch, the only result possible being, the thread breaks out, the bunch prevents the thread from working out to the back of the harness, so clings in the shed, makes a pick out, and will sometimes throw the shuttle. This means loss of production, also poorer quality of production, and the faults do not end here; it is utterly impossible for the workers to use the same energy when the air is dry as when a fair amount of moisture is in the air. Too much moisture is almost as bad as too little, for everything becomes damp and sticky, the weavers are always complaining that they have colds and other kindred ailments. Such elements certainly are not conducive to good results.

Various mills have different systems for humidifying the atmosphere: some still cling to the old method of allowing steam to escape through traps fitted in the floor, but happily they are becoming more rare, for the steam pipes tended to cause excessive heat at times which killed whatever value there was in the steam. In addition, there always seemed to be an accumulation of lint around the trap, and the floor and machinery for quite a space around never seemed clean.

Fig. 139 shows very clearly the advantage gained from the use of this system; the open fuzzy strand was photographed during the time that the percentage of moisture was very small; the air being what is commonly called in a dry state. The close strand with little if any fuzzy fibres was photographed after the moistening system had been installed, which conclusively proves the value of this system in obtaining relative humidity.

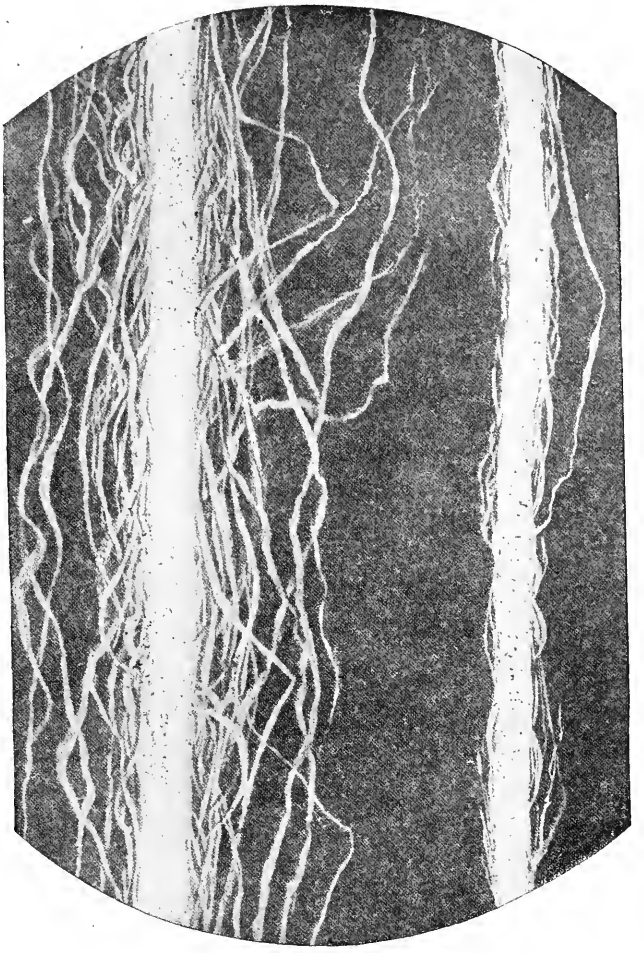
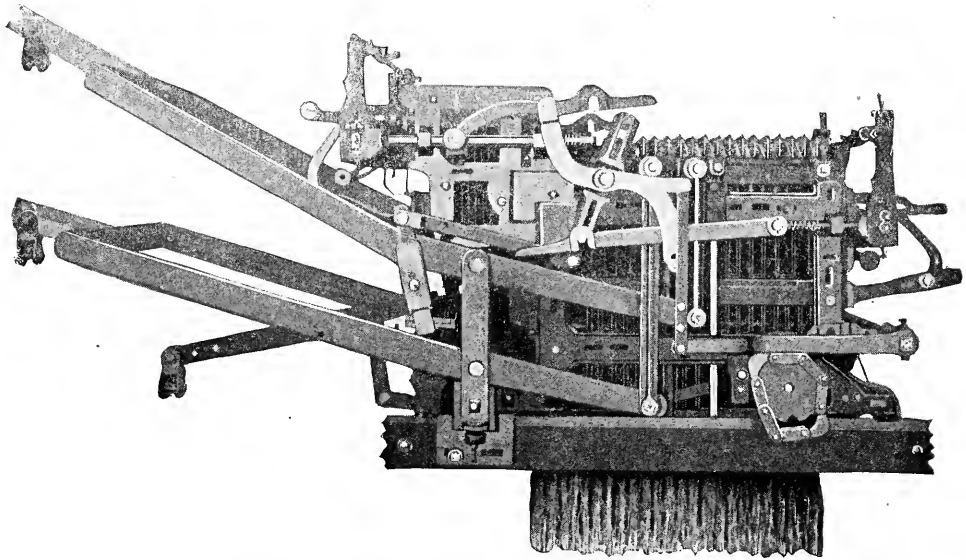


Fig. 139. Yarn Spun With and Without Humidifier.

The instrument for measuring the degree of relative humidity is in the form of a double thermometer, technically called hygrometer; to one there is connected a wet bulb; a wick attached to this and resting in a small quantity of water is so influenced by the atmosphere as to register on the hygrometer the degree of humidity. As the air becomes dry the moisture surrounding the wick is absorbed, thus lowering the indicated temperature in that thermometer, incidentally indicating the difference in the humidity of the room. If there was no evaporation from the wet bulb, it would indicate that the air in the room was thoroughly saturated and both thermometers would read the same.



CROSS BORDER DOUBLE-LIFT JACQUARD MACHINE
Thomas Halton's Sons

JACQUARD MACHINES

The term Jacquard Weaving may be applied to all harness weaving that is above the range of harness shafts, so that a jacquard machine is simply a shedding motion whereby a large variety of sheds may be formed. The greater the number of lifting hooks contained in a machine, the greater will be the range of patterns that may be woven. Jacquard machines range from 100 to 2600 hooks.

Since its introduction the jacquard machine has undergone many changes in regard to the methods of operating the different parts of the machine, but the principles remain the same.

Jacquard machines may be classed under four heads, as follows: *First*, Single Action Machines, meaning single cylinder machines; *second*, Double-Lift Single Cylinder Machines; *third*, Double Action Machines, meaning double-lift and two cylinders; and *fourth*, Rise and Fall Machines, which have a close-shed motion. There are also special machines.

When speaking of a jacquard, all the parts comprising the machine and the harnesses are included. These may be classified as follows:

(*a*) A number of wire hooks placed vertically in the frame of the machine.

(*b*) A number of wire needles placed horizontally between the wire hooks.

(*c*) A number of springs at one end of the needles.

(*d*) Tail cords or neck bands attached to the bottom of the wire hooks.

(*e*) Harness threads which are attached to a coupling that passes through the comber board.

(*f*) The coupling, which is usually composed of three or four parts as follows:

A lingo, usually made of various weights of wire and which is at the extreme end of the coupling; a double thread, commonly

termed a hanger, which attaches the lingo to a mail eye; and the mail eye, through which the warp yarn is passed. When there are four parts, a double thread termed the mid-piece or sleeper is attached to the top of the eyelet and is then fixed to the harness threads mentioned at *e*.

(*g*) The cylinder and its working parts.

(*h*) The griffe levers.

(*i*) The griffe.

Hooks. A description of the great variety of hooks and needles which have been used and which combine different ideas

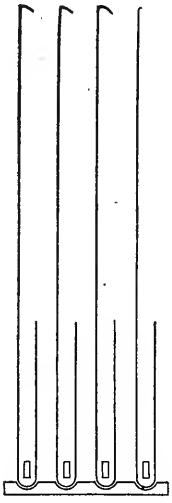


Fig. 1. Hooks Resting on Perforated Board.

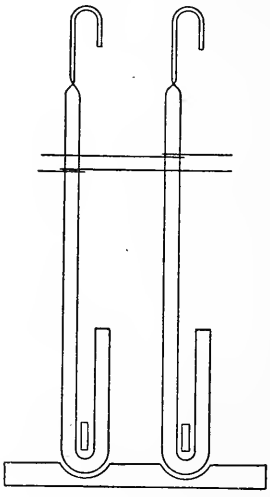


Fig. 2. Flat Hooks.

as to their relative values and adaption for the various machines in which they were or are used, will be both interesting and instructive.

In the old jacquard machine the hooks rested on a perforated board, through which the neck cord passed, and the bottom of the hook was bent up about five inches, as shown in Fig. 1. Bars were passed through the turned up portion, as shown in the illustration, to prevent the hooks from turning. The bars formed a frame which was lifted when the griffe was raised.

The next hook, as shown in Fig. 2, was flat. This also rested on a perforated board, and, to assist in keeping the hook in posi

tion, the needle was twisted around the hook. This kind of hook and needle required too much time and labor when one had to be replaced.

The illustration, Fig 3, shows the next form of hook that was used, and which is used at the present time in many French machines. This also rested on a perforated board. The chief object of this hook was to remove the necessity of having springs to force back the needles. At the point marked A, a rod passed through the hooks from one side of the machine to the other, which kept the hooks quite firm. Near the top of the hook at positions B and B^1, two more rods were placed, one being at the back of the hook and the other at the front, the bottom of the hook being held firmly, while the rod

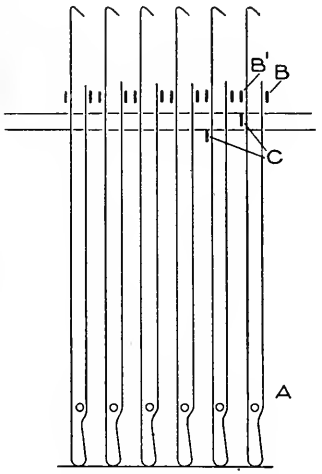


Fig. 3. Hook Sometimes Used on French Machines.

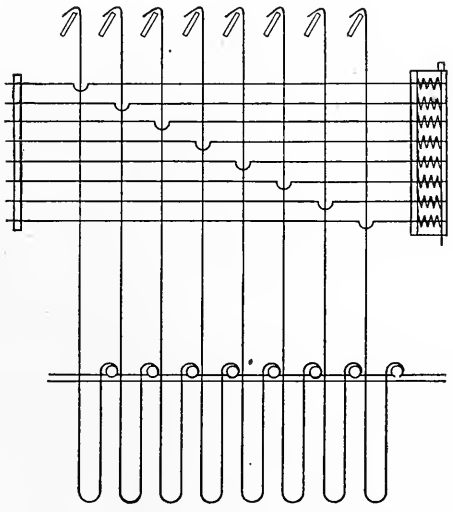


Fig. 4. Common Jacquard Hook.

B pressing against the back portion of the hook caused a certain amount of spring.

The rod B^1 was to prevent the hook from swinging under the blades of the griffe when the latter was descending. The needles used with this hook had an elbow which pressed against the front of the hook as shown at C.

What we shall term the ordinary shaped hook, but which formerly was much thicker, was next used. This is illustrated in

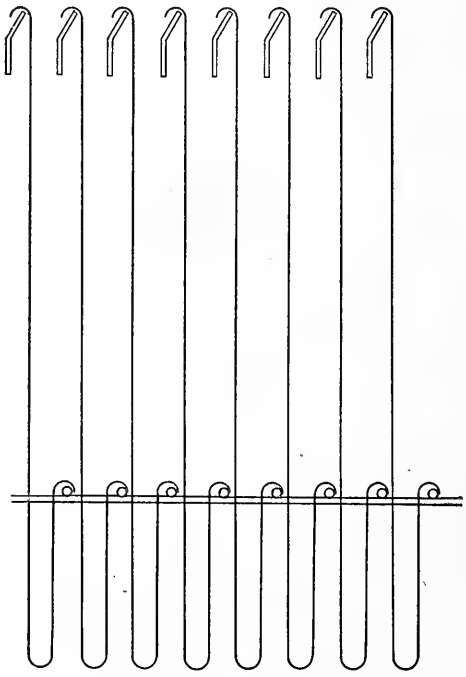
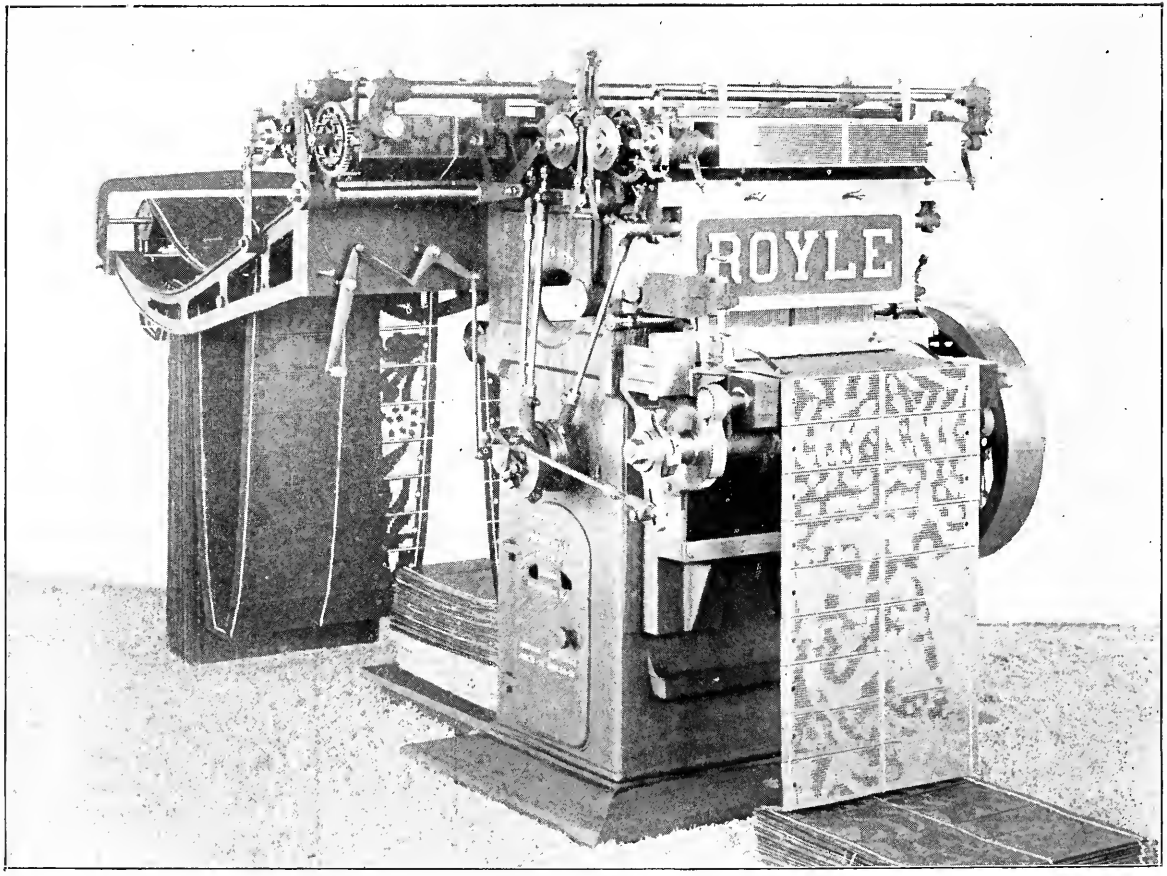


Fig. 5. Showing Deep Griffe Blades.

Fig. 4. The lower portion of these hooks passes through a grate, each hook passing through a single slot. When first used, these hooks were often bent or "crowned" under the griffe as it descended. In some cases the trouble was due to the wire from which the hook was made, but more often it was due to there being too great a distance between the point where the needle was in contact with the hook, and the griffe, causing the hook to swing or vibrate. To overcome this defect, deep griffe blades (shown in Fig. 5) were introduced.



ROYLE'S POSITIVE ACTION AUTOMATIC REPEATER WITH DOUBLE EXTENDED AND REVERSE CYLINDERS

The use of these deep blades made it difficult for the fixer to replace broken hooks, in addition to adding weight to the machine, so another change was made, deep and shallow blades being fixed alternately; using hooks shown in Fig. 6. In this arrangement the long hooks had a tendency to swing back under the short blade owing to the great length of the hook, when the loom was run at a high speed.

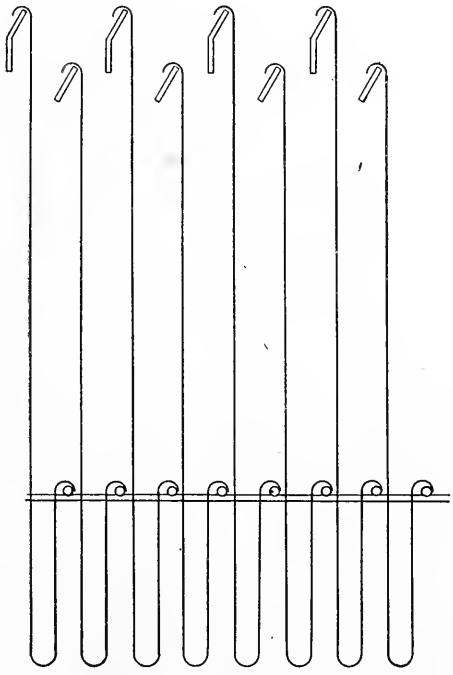


Fig. 6. Alternate Arrangement of Griffe Blades.

The hook illustrated in Fig. 7 was then introduced. It will be noted the wire extends some distance beyond the point when the wire was bent to catch on the blade of the griffe. While they were new, these hooks overcame the difficulty to a certain extent, but as soon as they became worn, the top portion of the wire would bend and break, falling into the machine.

In most of the jacquard machines used at the present time, the griffe has been lowered to within approximately one inch of the top of the needles and the hooks have been made of stronger

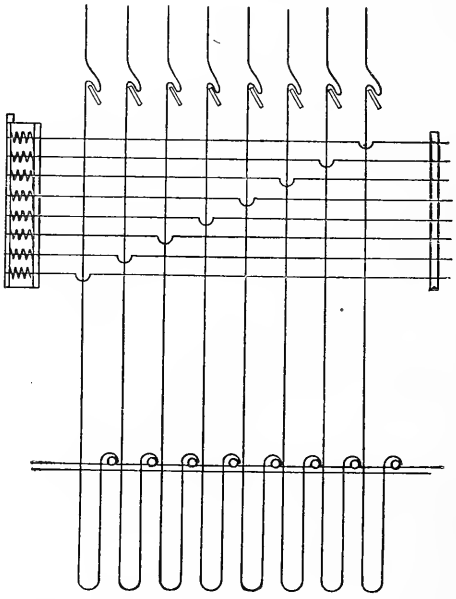


Fig. 7. Showing Hook Extending Above Griffe.

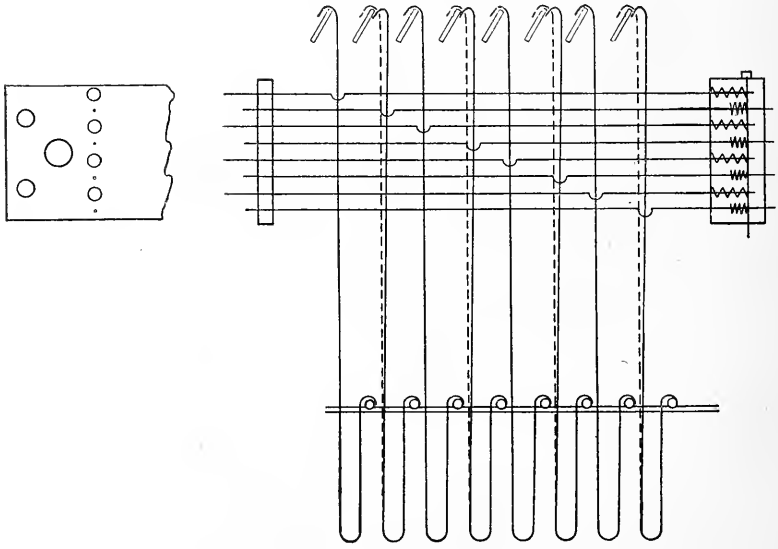


Fig. 8. Hooks Used at the Present Time.

material (shown in Fig. 8), enabling a more compact machine to be made.

SINGLE ACTION MACHINE

The illustration, Fig. 9, shows a jacquard known as the *Single Action Machine.* The chief feature of this machine is

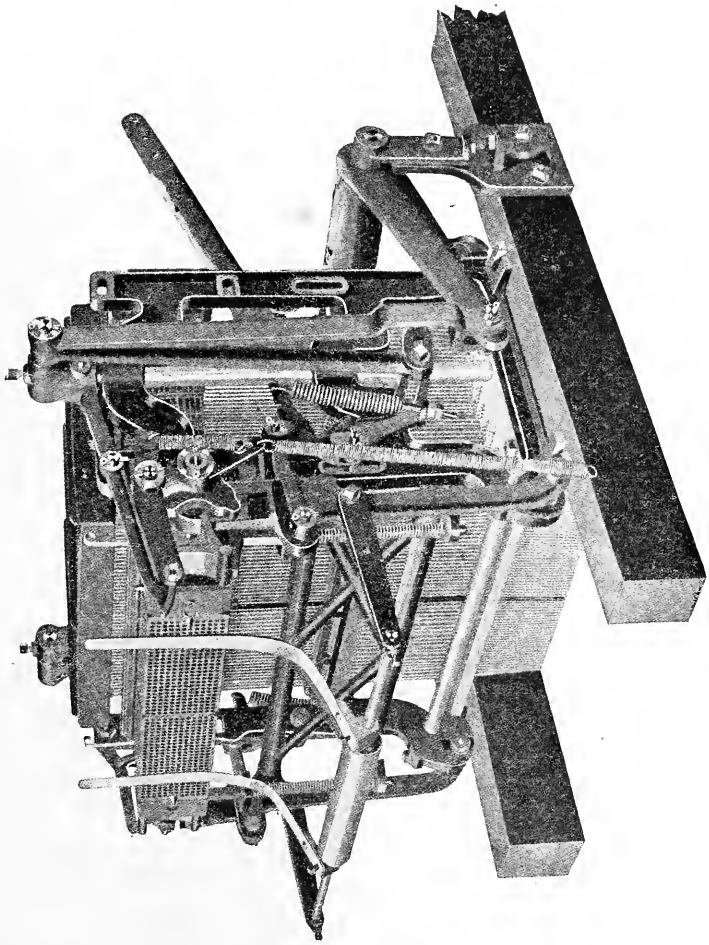


Fig. 9. Single Action Jacquard Machine.

that the same griffe lifts the hooks for every shed, so the griffe must descend before the next shed can be lifted. This allows all the yarn to be lifted from the bottom shed. The single action machine is convenient and well adapted to work when a

high speed is not required; ninety to one hundred thirty picks per minute being the most suitable speeds.

In the silk industry the single action machine is extensively used as there is no danger of the cards becoming crossed. This is a very valuable feature as wrong picks are often placed in the cloth by a double cylinder machine through the skipping of the cards.

Construction. The single action is the original idea and is the simplest machine. Fig. 10 shows a sectional view of a 400-hook single machine. The meaning of the term 400-hook is as follows: There are four hundred hooks and four hundred needles in the machine which are in rows of eight hooks and eight needles. It also means that there are four hundred harness threads to one repeat of the maximum pattern that can be woven by the machine. Nearly all machines have a few extra hooks (from 16 to 26) which are often classed with the regular number of hooks, but are chiefly used for extra work, such as selvedge, extra harnesses, etc. A pattern of less than four hundred to a repeat can be woven, by casting out some of the hooks.

Referring to Fig. 10, B is the needle board or plate, through which the points of the needles E protrude three-eighths or one-half inch. C is the griffe which is composed of eight blades; H is the spring box, containing four hundred brass springs which are placed against the back or loop ends of the needles, one spring for each needle. G is the grate through which the hooks F pass.

Needle Plate. In some cases the needle plate is made of wood and in others it is made of metal, but the former is undoubtedly the more economical from every standpoint. Particularly is this shown in the single cylinder machines where the cylinder travels at a faster rate of speed than a double cylinder machine, consequently there is more movement and a larger amount of friction between the needle and needle board or plate, which results in rapidly wearing out the points of the needles if a metal plate is used. Worn needle points cause a large amount of trouble, for in single cylinder machines the cylinder has a tendency to half-turn when the lay is pushed back by hand, and when the cylinder returns to the needle points the corner of the cylinder presses against them and invariably bends a number of the points

down on to the plate. This prevents some of the hooks which ought to be lifted from being lifted, and causes some hooks to be lifted which ought to be down.

A composition of powdered black lead and French chalk was used to prevent the needle points from wearing out, but it was discarded because the dust was constantly dropping into the harnesses and yarn, and also was very disagreeable for the weaver.

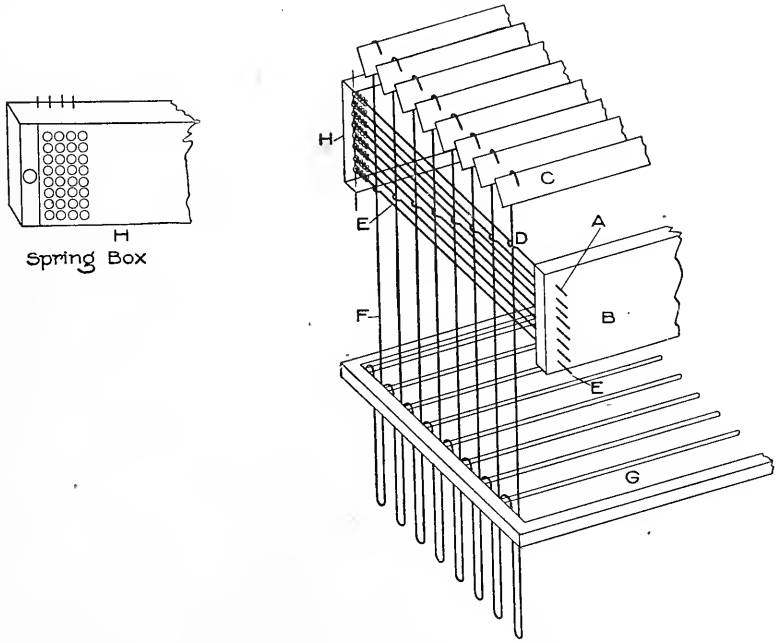


Fig. 10. Showing Arrangement of Hooks, Needles, Etc.

A needle board or plate for a 400-machine, has 416 holes, arranged in 52 rows with 8 holes in a row. The rows are divided by a groove into 26 rows on each side. There are also grooves at each end of the needle board. The grooves are for the lacings which hold the cards together.

The lacing naturally makes the card occupy more space at the ends and center, because it passes along the upper and under sides of the card, and if there were no grooves in the needle board, the needles would have to be made longer so as to allow the points to protrude farther out from the needle board; or when the card

was in contact with the needle points, the hooks would not be pressed back far enough to prevent them from being lifted. The grooves are also a great saving on the lacing of the cards, for if it came in close contact with the needle board every time the cylinder was drawn in, the lacing would soon be cut, and this often causes the breakage of cards.

The reason for the extra rows of needles, is to allow the selvedge to be worked by that row of hooks; also because a jacquard sometimes has patterns added that require additional harness at

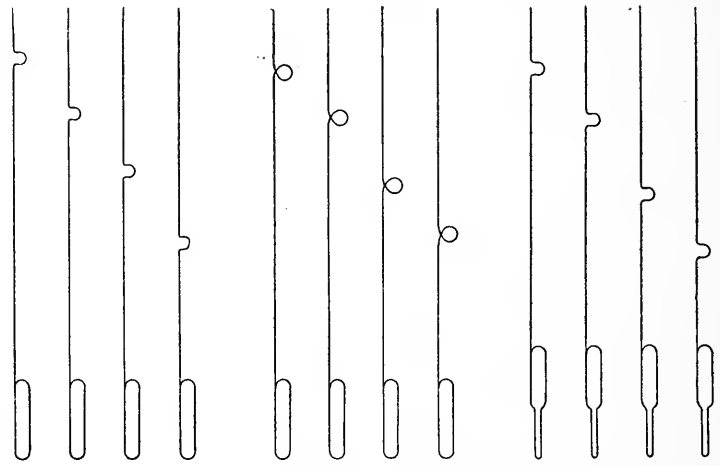


Fig. 11. Showing Loops for Springs.

the front and back of the comber board, and the extra needles are used for the working of the extra harness.

A spring box is seldom used on American machines to hold the springs that press back the needles, but where the spring box is dispensed with, a longer loop is made on the back end of the needle (see Fig. 11) and the spring is placed on the loop, with the cotter, which holds the needles. The spring box, however, is most certainly of value if it is made to fit squarely in the framework of the machine. The springs are kept cleaner and consequently will give good results; and if a spring should break, it can be replaced more readily in a spring box than if it were on the end of a needle.

There is, however, one disadvantage in using the spring box, for when the hole, through which the bolt, which holds the box in position, passes, has become worn, some of the needles will be pressing against the edge of the spring instead of the center, unless care is taken in fixing on the box. This causes the needles to stick in the box, preventing the hooks from working as they ought to do.

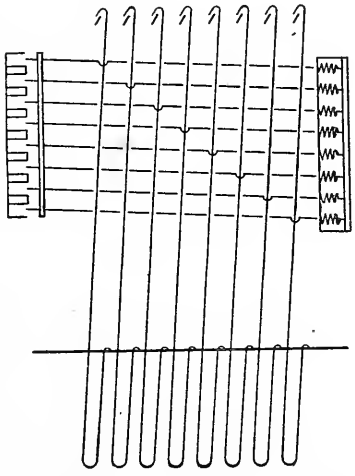


Fig. 12. Hooks Out of Perpendicular with Needles.

When placing hooks and needles in a machine, one row of eight needles is placed in first; that is, the needles are passed through the bars that extend across the machine from side to side, and into the holes in the needle board. On the bars the loop of the needle rests, the bars keeping each 52 needles separate. The first needle is the one that has the half circle, through which the hook passes, nearest the needle board at the top (see Fig. 10), and the others are graded down until the eighth is placed in. This will be the bottom needle with the half circle nearest the spring box H.

When the cotter has been placed through the loop of the needles, the hooks are placed in among the needles. The first hook is pressed through the half circle of the needle and passes on the outside of the others, which keeps the hook in position. The second is placed through the half circle of the second needle, but

passes on the outside of the first needle and on the outside of the lower needles. This rule is followed out until the eighth hook is placed in position.

The grate through which the hooks pass is sometimes made with extra rows of holes, and is also made so that it can be moved around to help in the setting of the hooks. For this reason, it is best, after placing in one row of hooks, to notice if they are straight in the grate. If they are not straight, and cannot be made straight by moving the grate, the next row of holes must be used. If the hooks are not straight, even though they may work

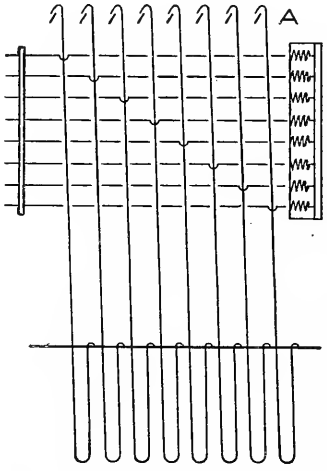


Fig. 13. Hooks Out of Perpendicular with Needles.

freely, the needles, hooks and grate will be worn out in a very short time.

The hook that passes through the first needle is considered the first thread in the pattern, although when standing in front of a single action machine, it is the last thread. In a machine that has the needle board divided into twenty-six rows at one side of the middle, and twenty-five at the other side, the twenty-six rows are always at the left-hand side of the machine, looking at the point of the needles. (So that the number end of the cards will be at the left hand side of the machine, looking at the top needle board.)

When all the needles and hooks have been placed in the machine, the frame in which the bars that support the top of the needle, are fixed, must be made perfectly straight with the needle board. If they are not straight with each other, there is endless trouble with the machine. In the first place, the loop of the needle presses down the spring when the needle is forced back by the card, instead of pressing the spring back straight in the box. This will cause the springs to wear out sooner and they will often stick, preventing the hooks from being lifted.

In the second place, the needle points will not be straight in the needle board. This causes the hole in the board to be worn crooked, also, the dust and oil that get into the back portion of the board has a greater tendency to bind the needles when they are not straight. The holes in the needle board at the back are counter sunk, which allows the needles to be placed in more readily when the machine is being fixed up, or when a broken needle has to be replaced

When the hooks and needles have been fixed, the grate, needle board and needle frame adjusted, the spring box is attached and every needle is tested and made to work freely. After this is done, the griffe is placed in the machine. It is absolutely necessary that the griffe be made to lift straight, and each blade or knife must be in exact position relative to the hooks, or there will be a number of the hooks either "crowned" or not lifted when they ought to be. The griffe is made so that each side can be moved either forward or backward, but it is sometimes necessary to bend one or two blades of the griffe so as to have them straight with the hooks. Figs. 12, 13 and 14 show crooked hooks and needles.

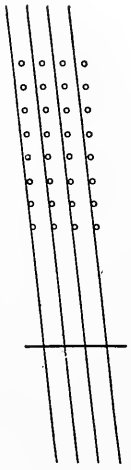


Fig. 14.

When the griffe is set, the top of the blade ought to be just touching the hook. If the hook is pressing too hard against the blade, either the needle point must extend farther out from the needle board, or the cylinder has to press hard against the needle board when the hooks have to be pressed off the griffe. Either case is detrimental to the machine. In the first instance, the cylinder requires to pass farther out from the needle board, to

allow the cards to clear the needle points when the cylinder is being turned, or there is a possibility of the edge of the card catching on the needle points, preventing the cylinder from turning.

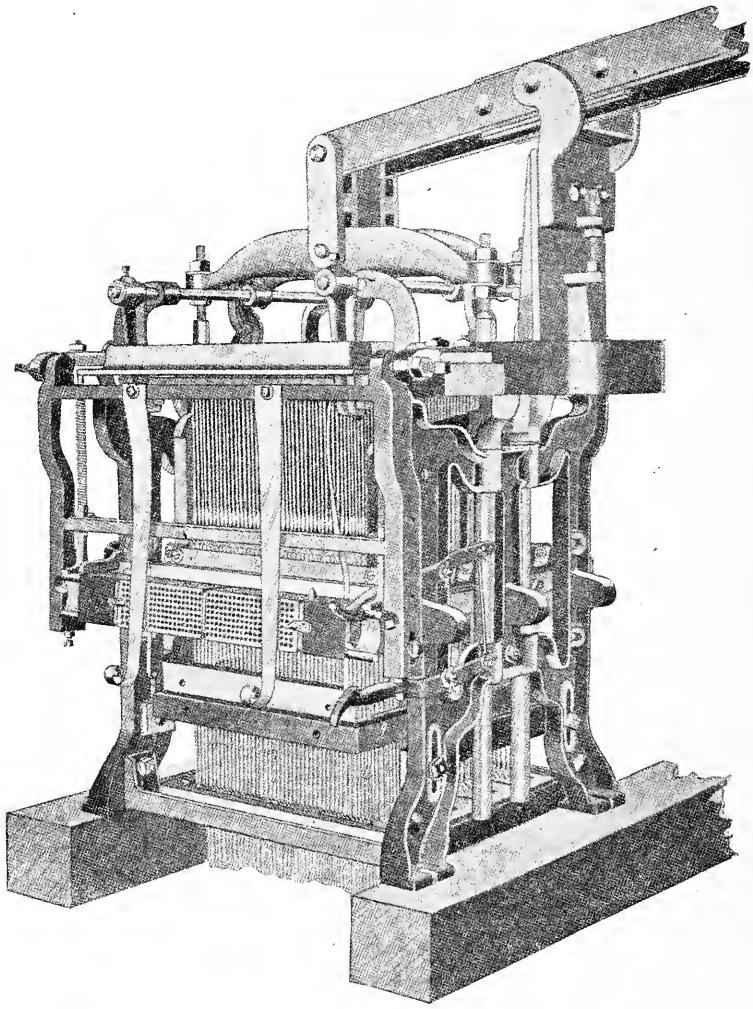


Fig. 15. Showing Overhead Lever Lift and Independent Batten Motion.

and causing misspicks. In the second instance, if the cylinder presses too hard against the needle board, the lacing is often cut, and the needles have a tendency to pierce the card where it is blank.

Having set all the inner parts of the machine, the next in order is the tying on of the neck cords. Carelessness in the setting of the inner parts so far mentioned cannot afterwards be rectified, and means the loss of years of work from the machine besides having endless trouble during the time it is working.

The Outer Workings of the Machine. There are five distinct methods of operating the movable parts of the machine: *First*, top or overhead lever lift and independent batten or swing cylinder motion; *second*, overhead lever and spindle cylinder motion; *third*, overhead lever and independent slide cylinder motion; *fourth*, bottom or cradle lever lift, and independent spindle cylinder motion; and *fifth*, bottom or cradle lever lift and spindle cylinder motion.

The first method is illustrated by Fig. 15. It consists of a lever at the top of the machine, or in some instances suspended from the beam that supports the ceiling. The inner end of the lever is connected by a link to the crossbar of the griffe. This must be fixed exactly in the center of the crossbar so as to give a straight lift to the griffe. To the outer end of the lever, a long driving rod is attached. The bottom end of the driving rod is placed on a stud attached to the hand wheel, which is fixed on the crank shaft of the boom when the machine is a single lift. The overhead lever is from thirty-six to forty inches long, according to the width of the loom. On the thirty-six inch lever the inner end, which is attached to the crossbar from the link to the supporting stud, fixed in the bracket attached to the framework of the machine, is about ten and one-half inches long, and the longer end, which is attached to the lifting rod, is twenty-four to twenty-five and two-thirds inches long. The throw from the center of shaft to the stud fixed to the hand wheel is four inches. This gives an eight-inch stroke on the hand wheel.

$$\frac{10\frac{1}{2} \times 8}{25} = 3\frac{1}{3} \text{ inches}$$

Allowing for the fall of the griffe below the bend of the hook the movement will give about a three-inch shed in the harnesses.

The batten or swing cylinder movement is shown in detail in Fig. 16. It is composed of five distinct parts as follows:

(*a*) Two small arms are fixed at the top of the machine, one at each side. Two pointed set screws with lock nuts are set in the arms and the batten or swing is supported on these points.

(*b*) The batten, which is in the form of a square iron frame.

(*c*) Two cups set in the batten frame, which support the cylinder. The cups are made of iron or brass and are held in place by a bolt with thumb screw on the outside of the frame of the batten. Set into the bottom of the batten frame and pressing

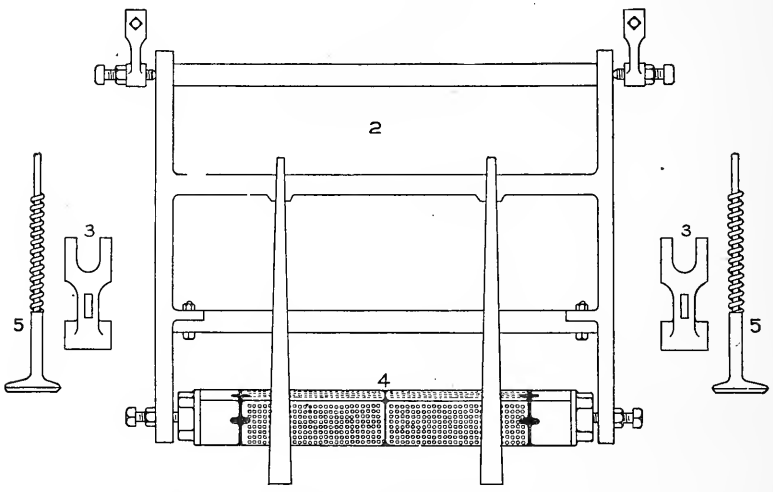


Fig. 16. Details of Batten or Swing Cylinder Motion.

upwards against the cups, are two set screws whose purpose is to raise or lower the cylinder.

(*d*) The cylinder. This is a square prism with a number of holes bored on each side to correspond with the needles in the machine. On each of the four sides of the cylinder and near each end there is a small brass peg (shown in Fig. 17) for the purpose of holding the card in the correct position on the cylinder. (The perforations in the cards should be over the holes in the cylinder). The pegs are set so they can be adjusted to the right or left. At the ends of the cylinder square iron castings with rounded edges are fixed.

(*e*) A spring hammer, the flat end of which rests on the casting on the end of the cylinder. What might be termed the handle of the hammer passes through the lower cross rail of the bottom frames and through the top frame. A spring is placed between the two rails and around the handle of the hammer. The object of the hammer is to keep the cylinder perfectly level so that the cylinder will strike the board level.

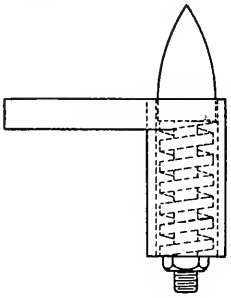


Fig. 17. Spring Peg.

Flat springs also are attached to the inside of the batten, the lower end of the spring pressing the card to the cylinder. It is impossible to overestimate the value of these springs, especially on single cylinder machines, for it would be almost impossible to work without them. Their great value is shown when the cylinder is leaving the needle board by preventing the card from swing-

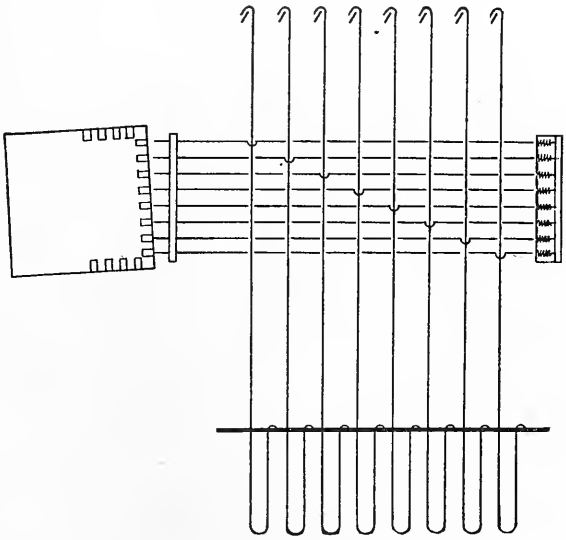


Fig. 18. Cylinder Out of True with Needle Board.

ing on to the points of the needles, and also preventing the cards from slipping off the pegs as the cylinder is drawn over by the catch.

The catch is fixed to the framework of the machine, and rests on the square casting fixed to the end of the cylinder. As the cylinder moves out, the catch comes in contact with the rounded edges of the square and in this manner the cylinder is turned. There is also another catch fixed underneath, but it is not in contact with the cylinder, and is adjusted so that it can be raised up in contact and the top catch raised from contact with the cylinder. This permits the cylinder to be turned back when a lost pick has to be found.

At each side of the batten frame toward the lower end, an arm is fixed. To these arms rods that extend downward are attached,

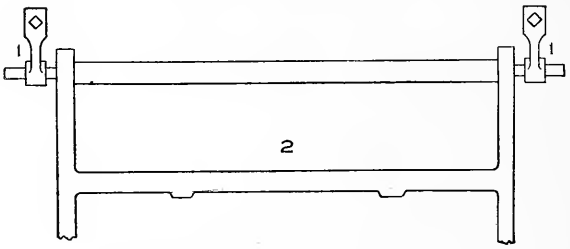


Fig. 19. Iron Bar Supporting Batten Frame.

and each rod is fixed to an arm that is set-screwed on a shaft supported by brackets fixed to the arch of the loom. At the end of this shaft another arm is fixed and is connected to the eccentric rod that is attached to the clamp that encircles the cam or eccentric. The cam is for the purpose of imparting motion to the batten. The cam generally used to operate the batten is about three and one-half inches from center of movement to extreme outside length of cam. The cylinder is moved out from the needle board from two to three inches.

For the saving of cards, a great deal depends upon the movement that is imparted to the cylinder. The less movement that can be given to the cylinder, the better; that is, of course, when obtaining the results required. The cylinder ought to be about one-quarter inch from the needle points when commencing to turn. Sometimes it is necessary to have the cylinder a little farther out, especially when the cards have been stored in a damp place and become warped so that they do not lie flat on the cylinder. In

this case, unless the cylinder is a little farther out from the needle points when commencing to turn, the edge of the card will catch on the needle points. This will throw the cards off the pegs and cause a pick-out. If the distance traveled by the cylinder is too short, it causes too sharp a turning of the cylinder, which has a tendency to jump the cards from the pegs; and if the cylinder moves out too far, there is too much friction on the working parts, as the larger distance has to be traveled in the same space of time as the shorter distance.

When setting the batten frame by either the set screws or the arms to which the set screws are attached, the principal point is that the cylinder must be flat against the needle board, both at the

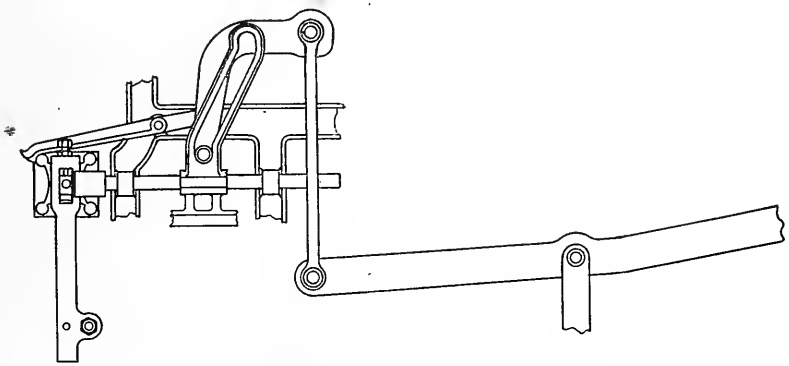


Fig. 20. Spindle Cylinder Motion.

top and bottom of the board, and have the needle points as near the center of the holes in the cylinder as possible. It is particularly desirable that all points be square and straight with the batten motion, because the batten, moving from a top connection, performs an arc movement, and if the cylinder does not lie flat against the needle board, some of the hooks will not be pressed far enough off the griffe, or the points of the needles will come in contact with the sides or bottom of the holes in the cylinder and in that case, hooks will be down when they ought to be lifted. Fig. 18 shows the cylinder set crooked with the needle board.

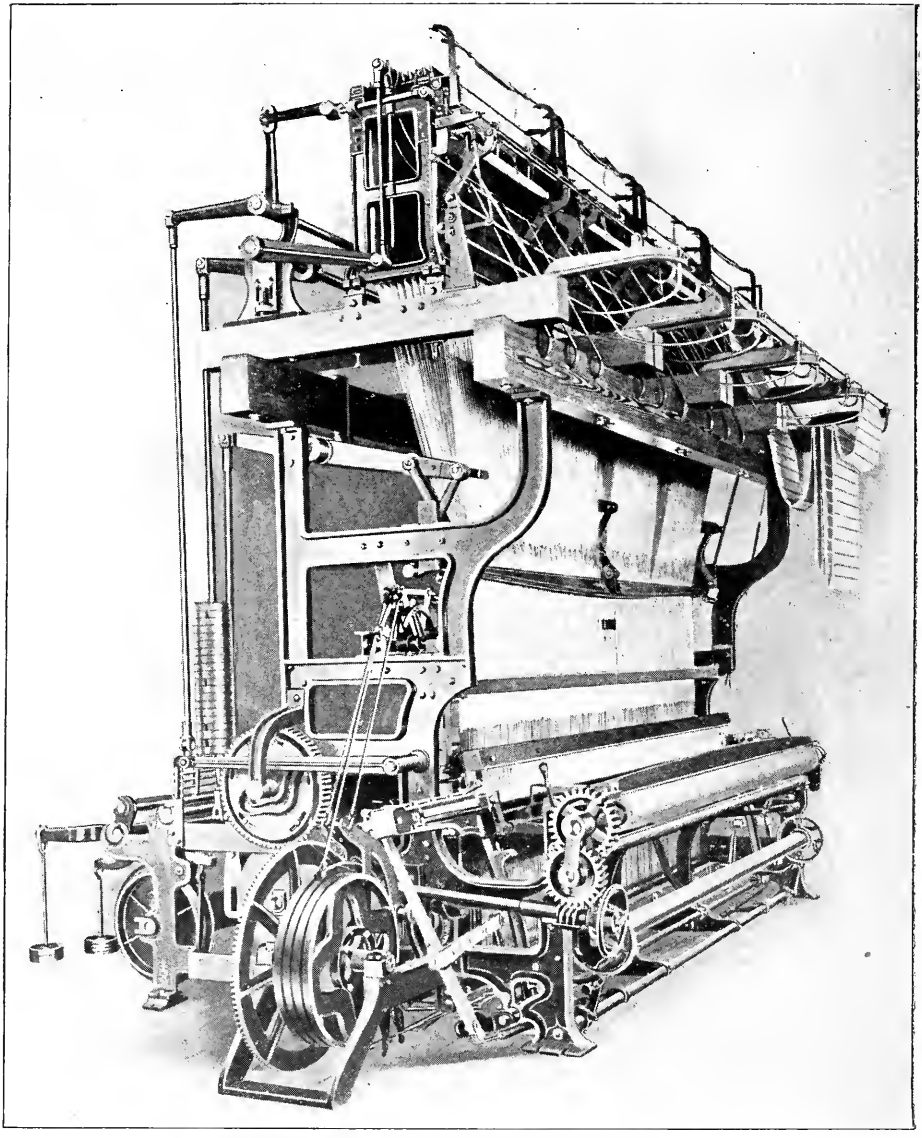
The set screw support for the batten frame is a very objectional feature as will readily be seen, for the frame resting and working on two points is a great strain and some part of the

screw soon becomes worn. This, of course, lowers the cylinder. When the cylinder is adjusted by turning the set screw, the frame is not only raised higher but is moved to the right or left, which throws the cylinder out of place, thus making double the amount of work to adjust it.

The method of supporting a batten frame on an iron bar is by far the best, as by this arrangement, the cylinder can be directly adjusted. The illustration given in Fig. 19, shows this method of supporting the cylinder.

In the second method of operating the movable parts (see Fig. 20) the top motion remains the same as in the first, but the method of operating the cylinder is different. Fixed to each side of the square iron frame that supports the cylinder, is an iron spindle, which passes through two brackets which act as slides for the spindle and are fixed to the frame of the machine. Attached to this cylinder spindle is a two-inch cranked slotted arm. Attached to the spindle of the griffe is a small extention on which an iron roller is placed. This iron roller sets in the slot of the cranked arm; the slot arm being about seven inches long. The seven inches is divided into three parts, the top and lower portions being perpendicular, to allow a rest for the cylinder when it is out from the needle board, and also when it is in contact with the needle board. As the griffe is lifted, the roller passing up the slot of the cranked arm forces out the cylinder. The distance the cylinder is moved cannot be changed to any great extent, neither can the time of the cylinder be changed, so that when a warped set of cards is being used, there is always the tendency for the cards to catch on the needle points.

In the third movement (see Fig. 21), the top motion is the same as the first and second, but the cylinder movement is distinct. A flat, iron casting which acts as a slide, is placed on each side of the machine. These slides are supported by small iron rollers, which are placed in brackets fixed to the frame of the machine. At the end of the slide, a brass cup for the cylinder and the spring hammer is fixed. A stud is attached to the slide. The rod connected to the clamp of the cam (or what is called the eccentric rod) extends upwards and is attached to an arm that is set-screwed on a shaft, but extends upwards. This movement is



KNOWLES BRUSSELS AND WILTON LOOM
Crompton & Knowles Loom Works

one of the best. The brackets that support the rollers are adjustable but seldom in the life of a harness do they require adjusting, for if the rollers are well oiled they last many years, because the friction is at the lowest possible point.

In the fourth movement a square cradle lever is placed in brackets near the feet of the machine, and connected to the top of the griffe spindle by means of an arm attached to the end of the cradle lever. This is shown in the double lift machine, Fig. 22.

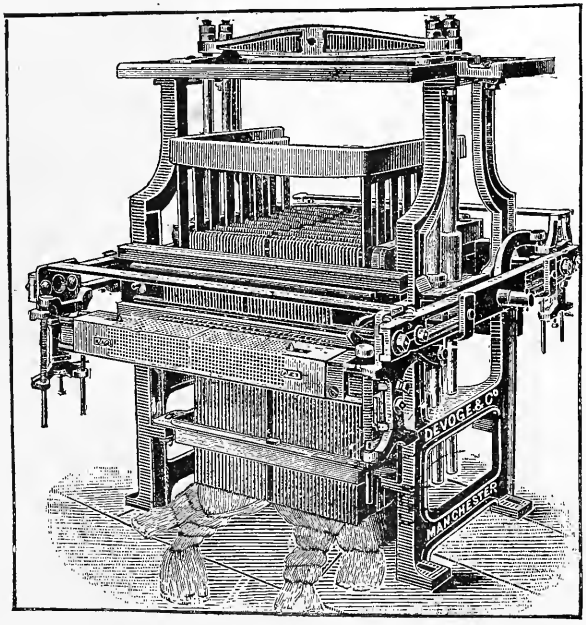


Fig. 21. Showing Overhead Lever Lift and Slide Cylinder Motion.

There is an arm at each side of the machine that is connected to the cradle lever. To the outer end of the lever the long lifting rod is attached. The length of the square lever is generally twenty-eight inches from fulcrum to connection of long lifting rod, and ten inches on the shorter end. This gives about a four-inch lift to the griffe. The cylinder is driven by an independent spindle motion. An iron spindle is attached to the frame that supports the cylinder. The spindle passes through two slide brackets fixed to the sides of the machine. Between the two

brackets and set-screwed on the spindle is an extension with a stud attached to the top of it. On this stud, the connecting arm from the lever is placed. The lever is supported at the top of the same bracket that supports the square lifting lever. To the outer end of the lever the eccentric rod is attached, but instead of using a cam to give motion to the cylinder, one part of a double crank is used, the other portion is used for lifting the griffe.

The fifth method is the same as the fourth with the exception that the cylinder is operated by the slotted crank arm, same as in the second method.

DOUBLE LIFT AND SINGLE CYLINDER MACHINES

The illustration, Fig. 22, shows a machine of this type. The same methods are used to operate this kind of machine as are used with the single action with this exception that there must be two lifting levers, either overhead or cradle levers. The reason for using this kind of machine is to have an open shed motion, and to gain a little extra speed; but this naturally drives the cylinder faster, consequently there is a greater damage done to the cards unless great care is taken with them and additional appliances used to prevent them from jumping off the pegs.

The needles and hooks used in this kind of machine are shown in Fig. 23. Each needle has two eyes or curves. The reason for two eyes is as follows: There is but one cylinder and two griffes, one of which is descending while the other is ascending. The cylinder has to pass in for every pick; that is, for each lift of the griffe, which necessitates the use of double the number of hooks; so that in a 400-machine, there are 800 hooks, without the extra ones. The top bend of every hook is turned in the same direction, that is, toward the needle board.

The hook that is used on this machine requires a deep bend at the top so as to have a firm grip on the griffe blade. This is necessitated by the method of controlling two hooks with one needle, for it sometimes happens that one hook is lifted while the other is pressed back by the cylinder, so that the same thread will not be lifted for the next pick.

The bottom of the hook is made in the form of a capital letter V. The reason for this is that it saves a considerable amount

of friction by allowing the bottom of the hook that is lifted to move back a little as the "partner" hook is being pressed by the needle. This shape of hook saves the grate through which the

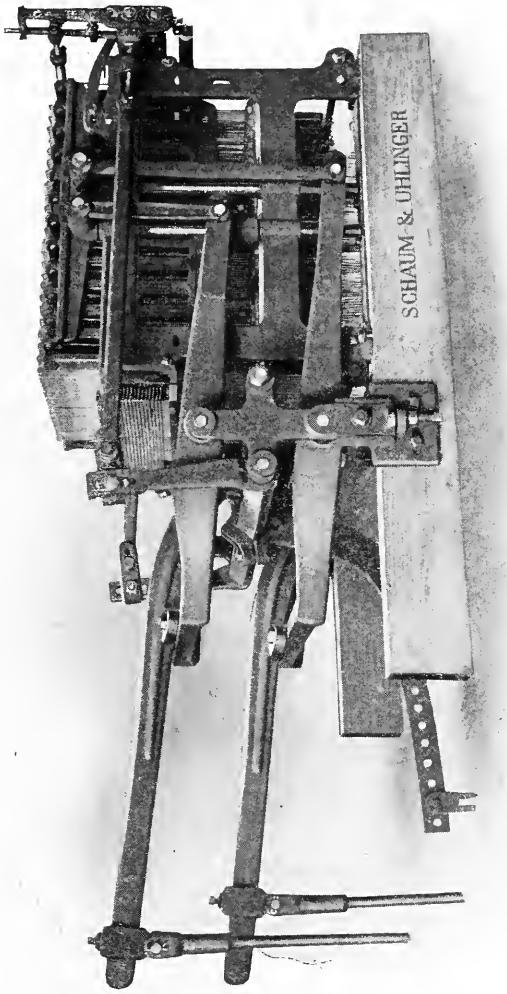


Fig. 23. Double Lift and Single Cylinder Machine.

bottom of the hook passes. Fig. 23 shows the position occupied by the hooks when one hook is lifted and the other hook (which passes through the same needle) is pressed off. The dotted lines show the original positions of the hooks.

In addition to the added friction on the needles and hooks, it takes considerably more time to replace a worn needle than it does in machines where single needles are used, for a rod has to be temporarily inserted that will press to one side the two hooks around which the needle has to go, and it is often necessary to take out the hooks until the needle has been replaced, particularly

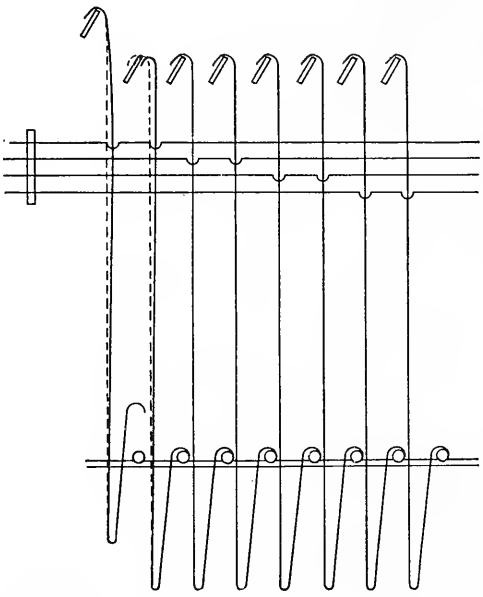


Fig. 23. Needles and Hooks Used in Double Lift and Single Cylinder Machines.

if the machine is an old one, or if deep blades are used in the griffe.

DOUBLE ACTION MACHINE

This means that there are two griffes and two cylinders. The same methods are used to operate the moving parts, as are used on the single action machines, but the lever and arms are used in a compound manner. This machine is undoubtedly the best, where large reproduction is aimed at, for it can be run 170 or 180 picks per minute. The illustration, Fig. 24, shows a double action machine.

The shedding motion is obtained by means of a double crank fixed on the end of the pick cam shaft, and to which the long lift-

ing rods are attached. This is shown in Fig. 25. Cams have been used to take the place of the double crank, so as to allow a dwell for the shed while the shuttle is passing through. It is particularly desirable in a broad loom to have the shed full open for a longer period in order to give clearance for the shuttle, but the

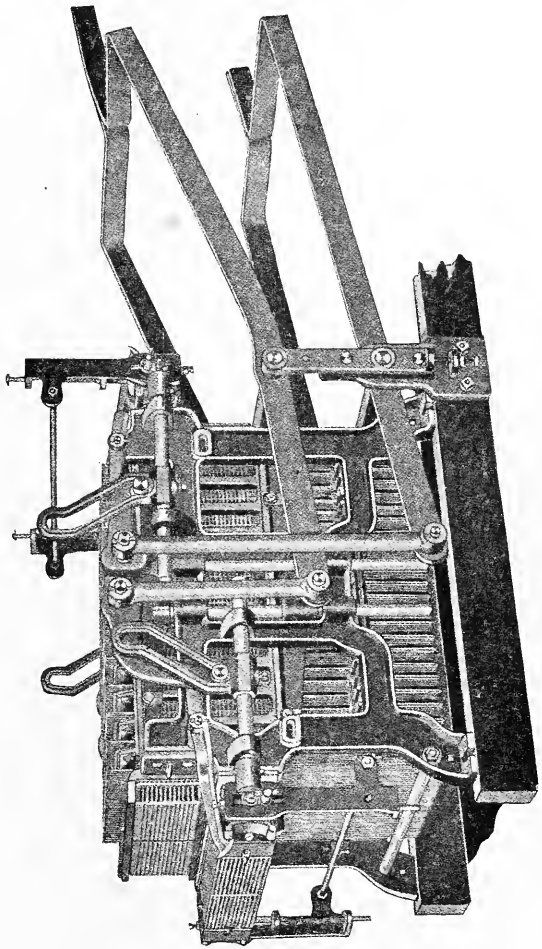


Fig. 24. Double Action Jacquard Machine.

cam motion was proven to be somewhat detrimental, owing to the quick rise and fall of the harnesses, which causes the lingoes to jump and to be constantly breaking off. The neck cords also were constantly breaking. The cam movement could be used successfully with a jacquard that had not many harness threads attached

to the neck cords, and had heavier lingoes fixed to the harnesses, but for general use, the double crank is best, as it gives a more even movement. There is also a short dwell while passing around the extended part of the crank.

The time to set the crank is to have it level, that is, the two extreme points horizontal, when the crank shaft is a little ahead of the bottom center, or to have the reed about $1\frac{1}{2}$ inches from the cloth when the shed is level.

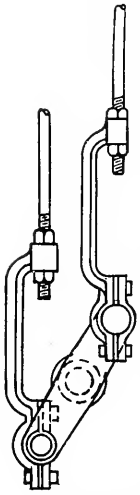


Fig. 25.

Owing to the general formation of the double action machine, that is, the use of two hooks for one set of harness threads, there is a somewhat uneven movement to the harnesses. When a griffe is descending and some of the hooks that are on the griffe are to be lifted for the next shed, and the hooks are passing each other at the center of movement, the angle of the harness threads is changed, for as one hook is lifted from the top shed, the neck cord attached to the hook that is at the bottom is slack. When this hook is raised for the next pick, at the point when all the slack cord is taken up, the uneven movement is caused, the harnesses swinging over into the line with the lifting hook. The results from this movement are not so harmful if the jacquard is tied up proportionally and run at the right speed; but when the machine is run too fast and the lingoes are too light, also when the neck cord is too short, a large amount of trouble is caused.

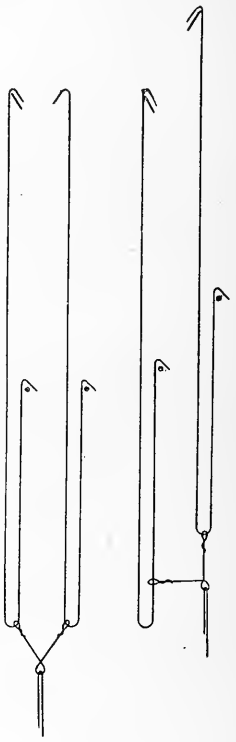


Fig. 26. Showing Connection of Neck Cords to Hooks.

Instead of connecting the harnesses to the hooks, by means of two neck cords, one is used as shown in Fig. 26. The link answers the purpose for which it is intended, that is, to take away the slack

neck cord. It also reduced the uneven movement. However, unless the hooks are kept perfectly straight, the link will not work, and it is common for a hook to be bent a little underneath the grate.

When one neck cord breaks on the ordinary double action machine, the defect is not readily seen, because the harness cord will be lifted by the other hook, unless it is a pattern where that particular hook from which the cord has broken is lifted very often. When the link is used, all the harness threads that are

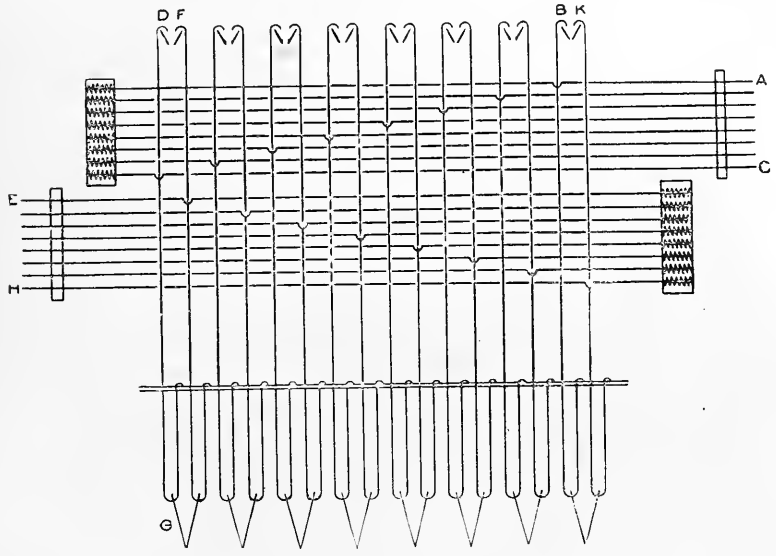


Fig. 27. Arrangement of Needles and Hooks in Double Action Machine.

attached to the link will fall, owing to the use of only one neck cord; this also occurs on the single action machine.

Needles. The illustration Fig. 27 shows the arrangement of needles in a double action machine. The first needle at the top marked A, controls the hook B, passing down in regular order until the bottom needle in the right hand needle board, marked C, controls the hook D. The first needle in the left hand or bottom needle board, marked E, controls the hook F, which is the partner to D, that is, F and D control the same harness threads, as will be noticed by the connection at the bottom G. The eighth needle in

the bottom needle board, marked H, controls the hook K, which is the partner hook to B. The bottom set of needles is exactly like the top set. They are placed in the same relative position, but work from the opposite direction.

There being two cylinders on this type of machine, one passes in as the other is going out. Both cylinders turn toward the machine as indicated by the arrows, and a glance at the two cards A and B with holes marked 1 and 2, and needles marked the same will show the two hooks F and D control the same harness threads.

It will be noticed that one hook has the top bend bent backward, while the other bends forward in the same direction as the

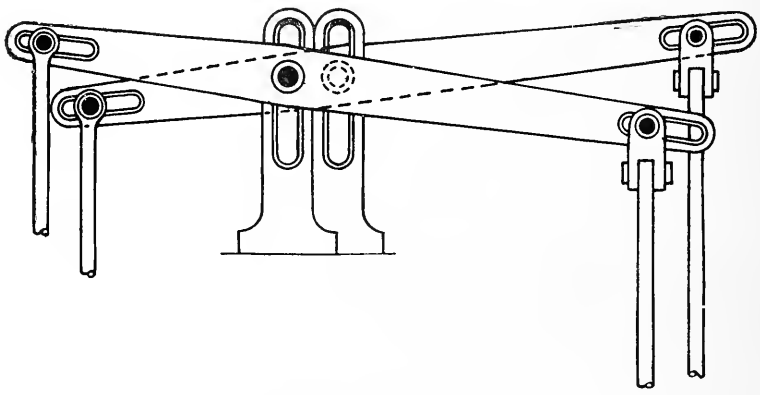


Fig. 28. Showing Levers, Supports and Studs.

lower bend of the hook. The reason for this latter is that it would require more space in the grate and the needles would have to be longer, which would make a broader machine if the same shape of hook were used; so that by the use of these hooks, considerable space is gained.

When cutting cards for a double action machine, each card is cut from the design singly, just the same as if cutting cards for a single action machine. After the cards are cut, they are divided, the odd numbers from the even numbers, so that when laced they form, as it were, two sets of cards, one set being placed at one side of the machine and the other set at the other side of the machine.

A double action machine is composed of double the number of working parts that are on a single action machine, but they are

placed so as to work in different directions, with the exception that with an independent cylinder motion only one eccentric rod is used, and the eccentric is placed on the pick cam shaft. But if the cylinders are operated by a spindle motion, a slotted crank arm is attached to the lifting rod of each griffe and the cylinder is moved out as the griffe to which it is attached is raised, one cylinder moving out from contact with the needle board as the griffe, that comes in contact with the hook controlled by the needles of

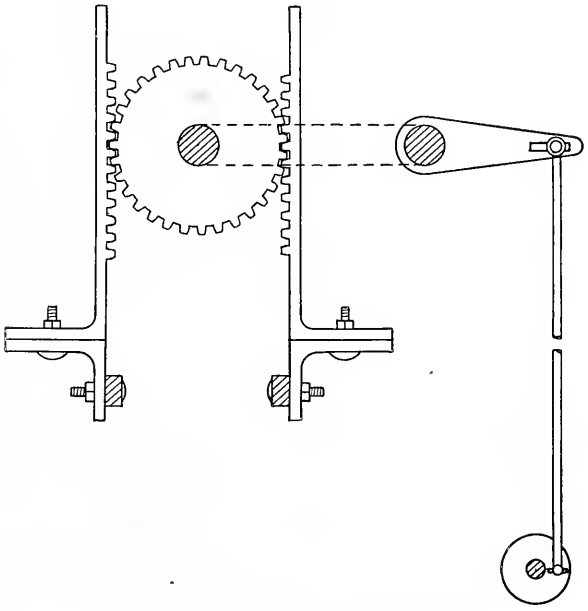


Fig. 29. Rack Method of Lifting Griffe.

that board, is raised, at the same time the other cylinder is passing in towards the needle board while the second griffe is descending.

When using the cradle lever on a double action machine, it is necessary to have two different sizes of lifting cranks to allow extra lift for the difference in length of the levers, owing to one of the levers working on the inside of the other. The length of levers used is about 30 inches for the longer end, from fulcrum to connection of lifting rod, and 13 inches for the shortest end on the longer lever. Fulcrum to connection of lifting arm on the shorter lever is 25 inches, and 10 inches on the shorter end. The double

crank is made so that the one with the 12-inch stroke is attached to the shorter lever, and the 10-inch stroke operates the longer lever.

The cradle lever lift is used only on machines that have the harnesses attached to them by the cross tie system, because by the straight tie system the machine is turned in the opposite direction; that is, one set of cards would be over the cloth in the loom, and the other set over the warp; and in the cross tie system the cards are over the sides of the loom or over shuttle boxes.

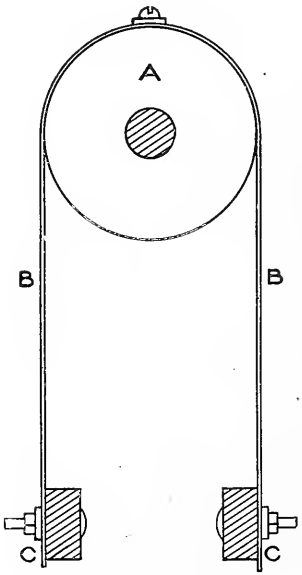


Fig. 30. Pulley and Belt for Lifting Griffe.

The top lever lift is considered by many to be the best method of operating the griffes, and this method can be used whether the harnesses are attached by the straight tie or the cross tie system. All that is required to be changed is that where as in the straight tie both the levers are on the same stud, and fixed to one support, the levers for the cross tie are placed on separate studs with separate supports. The reason for using separate supports and studs is to meet the different positions of the griffe bar. (See Fig. 28.)

Other lifting methods have been successfully tried on double action machines; one being a rack movement shown in Fig. 29 and another a pulley and belt lift shown in Fig. 30.

The rack movement is as follows: A $1\frac{1}{2}$-inch iron shaft is supported in bearings fixed to the top of the machine. This shaft extends over the end of the machine. The supports are bolted to the cross rail of the griffe, and on these supports the racks are fixed. The shaft passes between the two racks, and the gear is fixed on the shaft in contact with the rack. An arm is set-screwed on the outer end of the shaft, and to this arm a long lifting rod is attached. The bottom of the rod is placed on a stud attached to the face of a round iron plate that is set-screwed on the pick cam shaft.

In Fig. 30 the pulley A is supported on a shaft in the same position as the gear for the rack motion, and to the pulley a strip of belting B is attached, each end being fixed to the cross rail of

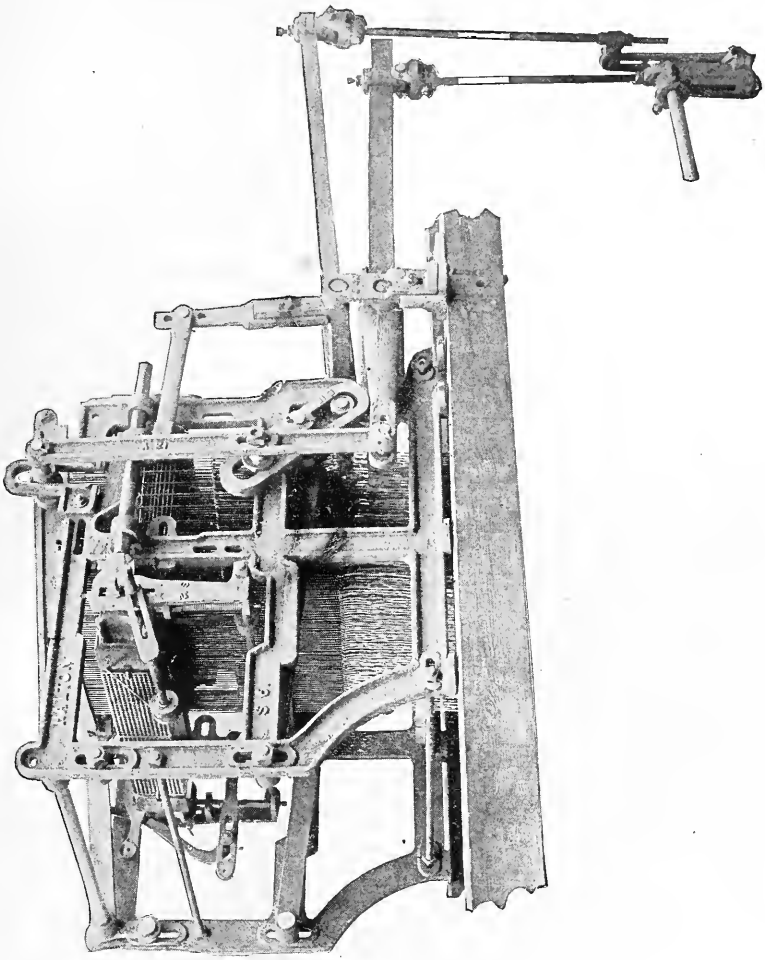


Fig. 31. Type of Rise and Fall Machine.

the griffe at C. The belt motion is a simple arrangement, but the griffe must act freely and perfectly straight or the griffe will not descend low enough to allow the hooks to be pressed off by the cylinder.

THE RISE AND FALL OR CLOSE SHED MACHINE

The illustration, Fig. 31, shows a machine of this type. Its purpose is to have all the harnesses level at the center movement. The same working parts are used on this machine as are used on the single action, the distinctive difference being that cranked levers are attached to the usual lifting levers so that the grate through which the hooks pass can be raised and lowered, and so that the griffe is raised only half the usual distance.

After the cylinder has pressed off the hooks that are not to be lifted, the grate descends with these hooks, and at the same time the griffe raises the hooks that are to be lifted.

On some rise and fall machines, a batten cylinder motion is used, but is fixed in the opposite position from the usual batten motion; that is, the batten swings from the bottom instead of from the top of the machine, the set screws that hold it in position being placed in brackets fixed near the feet of the machine.

These machines cannot be run at a high speed, 130 being considered average, but faster speed is obtained when the pattern is equally balanced so that about the same number of ends are raised, as are falling. This style of machine is now extensively used for weaving table cloths, silk goods, etc.

REVIEW QUESTIONS.

PRACTICAL TEST QUESTIONS.

In the foregoing sections of this Cyclopedia numerous illustrative examples are worked out in detail in order to show the application of the various methods and principles. Accompanying these are examples for practice which will aid the reader in fixing the principles in mind.

In the following pages are given a large number of test questions and problems which afford a valuable means of testing the reader's knowledge of the subjects treated. They will be found excellent practice for those preparing for Civil Service Examinations. In some cases numerical answers are given as a further aid in this work.

REVIEW QUESTIONS

ON THE SUBJECT OF

WARP PREPARATION

---

1. Can a spooler be run at the same speed, regardless of the grade of cotton that is in the yarn, providing the counts are the same? Give reasons for your answer.

2. Suppose a change was being made, and cop yarn had to be transferred instead of yarn from the bobbin; what change must be made on the spooler?

3. Describe the bobbin-holder. How would you set the bobbin-holder to obtain the best results?

4. How would you increase the traverse on the builder motion?

5. Suppose the spool were slipping, and it was not caused by a loose band; what would you do to remedy the fault?

6. Suppose more yarn were being placed on the spool at one end of the traverse than the other; how would you remedy this?

7. Describe the motion that builds the convex-shaped spool.

8. What is the purpose of the warper?

9. Describe the long-chain beamer. Of what value is the swinging comb on this beamer?

10. Which is the most economical system, to run several chains with a small number of threads in each chain, or run one chain with a large number of threads in it, both having to be split afterwards on the separating machine? Why?

11. Describe the difference between the two systems of making warps, long and short chain. Which is the best and most economical of the two for general colored work? Why?

12. Suppose the beam or press weights were not placed on the warp as soon as it was started, what would be the result?

13. What is the value of the faller rod?

14. Describe the slow motion. Of what value is this motion?

15. How can a beam-warper be changed to a ball-warper?

16. Explain the advantage of the linking machine.

17. What processes do the yarns that are to be dyed pass through before they reach the slasher?

18. Is it possible to prevent the yarn from running on the warper-beam in ridges? If so, how?

19. Describe the warper stop-motion, and also state its value.

20. Of what value is the "Straw" winding machine?

21. Describe the method of imparting motion to the warper-beam?

22. Describe the size vat, naming the rollers that are in it in their right order, stating your preference of the two vats, jacketed or one with the perforated pipe, giving reasons for your preference.

23. What is the best covering for the squeeze rolls? Why use this covering in preference to others?

24. Which do you consider better, a gear drive for the cylinder, or to allow the yarn to draw the cylinder around? Why?

25. Of what use are the split rods?

26. How is yarn affected while passing around the cylinders?

27. What is the purpose of the slasher?

28. What is the value of sulphate of magnesia? Of chloride of zinc?

29. How must the slasher be run to obtain the best results?

30. What would be the result if the press roll were too narrow for the beam? Suppose the press roll were not placed against the warp when it was first started, or there were not sufficient weight on the roll, what would be the result?

REVIEW QUESTIONS

ON THE SUBJECT OF

WEAVING

PART I

1. What is the first principle movement in weaving? Why should this principle be considered when purchasing looms?

2. Which would you consider the best shedding cam for all round work? Why?

3. What are the three essentials for good shedding? What would result from careless setting of these parts?

4. Name the parts of the Bat-wing picking motion.

5. Why use a lubricant on heddles? Which is the best for the purpose, tallow or oil? Why?

6. What is meant by cover on cloth? Is this an advantage or not?

7. What is meant by the dwell of a cam?

8. What is meant by gradually developed power in the picking motion?

9. Describe what picking means.

10. Describe the two methods of fixing the picking stick. Which do you consider the better, and why?

11. Describe the three different shapes of shoes; which is the better, and why?

12. How would you attach the heel spring to obtain the best results, and why?

13. How would you set the shoe to obtain the best results, and why?

14. Is there any advantage gained from an oversight of the heddles? If so, what is it?

REVIEW QUESTIONS

ON THE SUBJECT OF

WEAVING

PART II

---

1. What is the purpose of the filling stop motion?

2. Describe the alternate filling stop motion.

3. Of what value is the protection motion on a plain loom? Describe how this motion works. How would you set the dagger in relation to the receiver?

4. Describe fully the Crompton Gingham box motion.

5. What particular points must be attended to, when fitting a new set of boxes to the loom?

6. Describe what would occur from a worn receiving plate on the protection motion. How would this occur?

7. Describe the two distinct shapes of forks on the alternate filling stop motion. Has one any advantage over the other, if so, how?

8. Of what value is the lock-knife on the Knowles Gingham box motion? Give the timing of the lock-knife.

9. What is liable to occur from a worn picker and picking-stick? Describe fully.

10. Describe the center filling stop motion.

11. What is liable to occur from the following on the protection motion: worn dagger point, dagger too long, dagger too short? Describe how the faults occur.

12. Describe what faults occur from the boxes binding or being too loose in the slides.

REVIEW QUESTIONS

ON THE SUBJECT OF

WEAVING

PART III

---

1. If ten looms produce 6,500 yards in 11 days, how many yards will 35 looms produce in 9 days?

2. What is the actual length and weight of warp yarn in the following pieces of cloth? Mercerized and fancy stripe, 32 reed, fancy 4 in 1 dent, mercerized 2 in 1 dent, $31\frac{1}{4}$ inches in the reed, spaced 1 inch of fancy $\frac{3}{8}$ inch of mercerized, finish with 1 inch of fancy, making 23 spaces of fancy, 22 spaces of mercerized; 30 pieces of cloth 45 yards in length; mercerized stripe takes up $3\frac{1}{2}$ per cent, fancy stripe 4 per cent. Fancy stripe 40's cotton, mercerized $\frac{2}{2}\frac{}{0}$'s.

3. If the filling in the cloth has a tendency to drag at the sides as it passes over the breast beam, how would you remedy the fault?

4. What is the production of a loom running 180 picks per minute, 58 hours per week, 72 picks per inch? Allow $12\frac{1}{2}$ per cent for stoppage.

5. Suppose the loom was continually stopping without the filling breaking, what method would you pursue to find the cause?

6. Name at least 10 causes of shuttle flying or jumping out, and explain how they cause the result.

7. A weaver is paid $8.30 for producing 19 pieces of cloth, each 48 yards in length; what is the cost per piece and yard?

8. Suppose the warp yarn was being broken continually in the same place, what would you consider the cause?

9. What weight of warp yarn would be required to make a warp of 80 pieces, 48 yards in a piece, 2,360 ends in width, 35's cotton? Allow 3 per cent waste.

10. If you had a loom making cockly or uneven cloth, where would you look for the cause?

11. A weaver produces 280 yards of cloth, and receives $5\frac{1}{4}$ cents per yard, what is the amount received?

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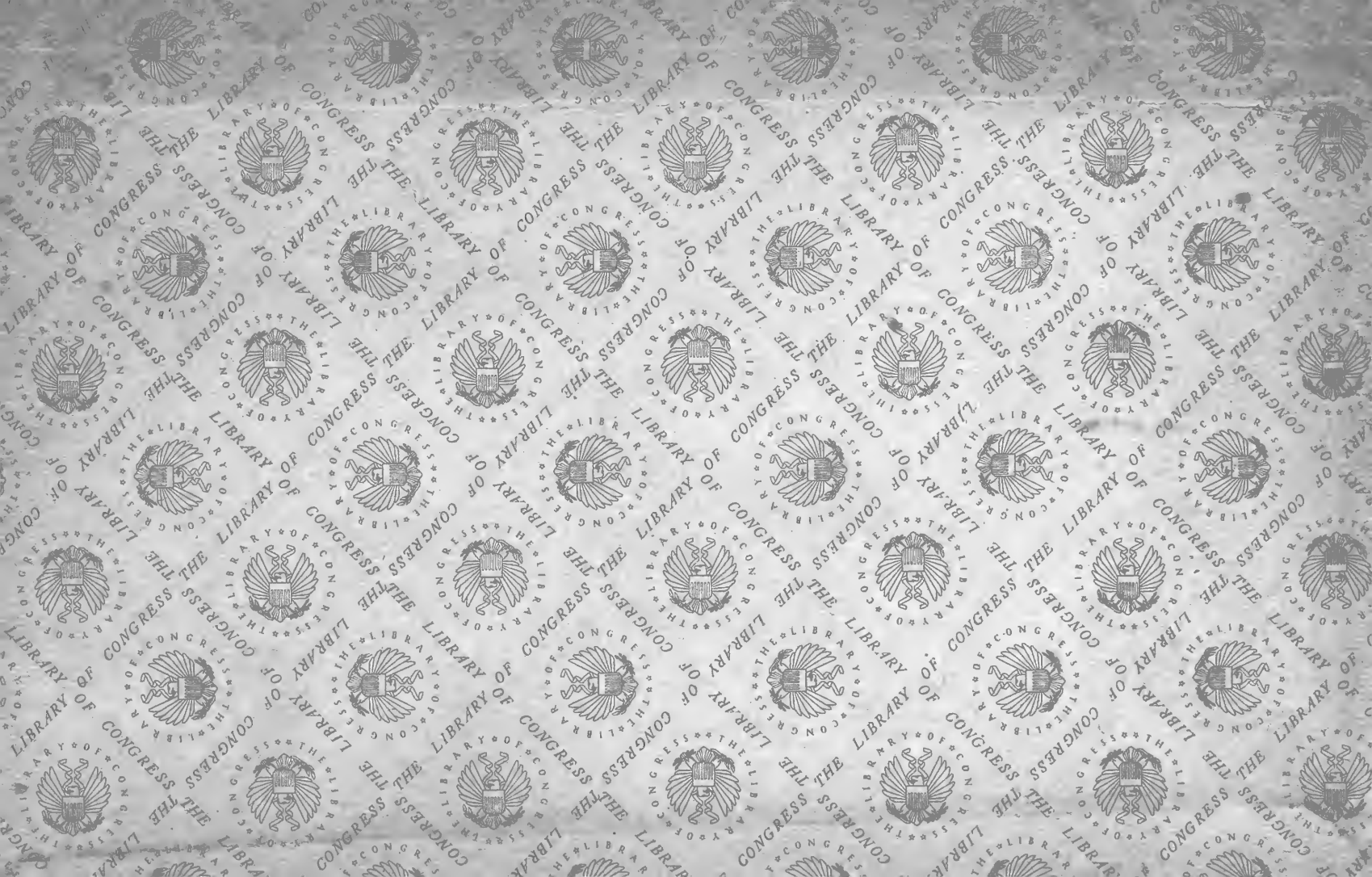
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